MODIFICATION OF POWER DISTRIBUTION PANEL

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DURGESH PANDEY

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ABSTRACT

This thesis is part of a product modification and optimization process of company ABC (modified name due to confidentiality) which specializes in low voltage panels and other electrical supplies.

The main objective of the thesis project was to document the technical drawings of a few key parts of the current design of the distribution panel and later to make modification and optimization of the design of specific model. The design should meet all of the safety and design standards formulated by the governing bodies in Finland and in the European Union.

After the end of thesis project, new modifications have been made on the model, which will lead to an optimization of the product with calculated possibilities of financial benefits to the company. The technical drawings were documented for further use. A new design was created with the reference of the layout. Minor other design changes were made on the parts of the panels.

Keywords Distribution panel, Sheet metal design, Technical drawing, Optimization

Pages 31 pages + appendices 40 pages

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1 INTRODUCTION

Company ABC is a manufacturer of electrical systems whose products range from comprising wire and cable harnesses to electrical cabinets. The company manufactures CE-approved low voltage switchboards and panels as per costumers needs. One of the products is a metering panel for residential buildings. Currently the company receives parts of the panel through their suppliers. They assemble these parts with electrical wire and parts to get the final product. Now the company has started to develop own mechanism to manufacture sheet metal parts. So they are examining modification and optimization, making technical drawings and evaluating the pricing and market demand. As part of the process, this thesis focuses on one model of metering panel which they supply. The thesis project included three major steps: Technical drawing, modification and optimizing.

There are three important phases in creating technical drawings. The initial phase here was to create the technical drawing for a few important parts of the old metering panel. Secondly technical drawings were made for the assembled old metering panel. Both 2D and 3D drawing are to be proposed. The third phase with technical drawings was related with the optimization process of the current model. The layout for the modification was to be created. This layout was followed by creating a new efficient design, considering the demand of the commissioner, existing requirements and optimizing of product as to both quality and price.

The technical drawings for the current part were intended to be created based on the documentation records of the models which were being already produced. This record can be vital during the repair work or replacement of the panel for costumers. A computer aided drawing software is to be used for this phase of thesis project. Secondly, the design of the new panel was made on the basis of the layout presented by company. The new design made according to the proposed layout was hoped to solve the some issues of numbers of meter a panel could hold, its size and other small features.

All the design that was created followed constrains provided by the European Union and the national governing bodies. The new design should optimize the product and keep7improve the safety features.

2 METERING PANEL

Figure 1: A type of a metering panel (vvsystems 2013).

A metering panel as illustrated in the Figure 1, is a key electrical appliance that records all the electrical power going to apartments, firms, buildings or certain areas. It consists of a metallic or plastic box with a meter reader, emergency breaker and safety buttons. So metering panel works as metering unit and emergency power breaker on the case of emergency. It records the amount of power consumed by an individual apartment or an office or a circuit, records the time of consumption and other electrical data and logging. Along with other electrical wire and components, there are insulator, usually rubber insulator to protect interior electric parts from dust, water and other particles that causes obstacles or hazardous conditions. There are different classification of metering panels as per the level of protection it has, which is regulated by electrical and standard governing bodies. These classifications are called IP classification numbers. (Accuenergy 2016.)

2.1 **Type of metering panel**

2.1.1 Classification of electric panel on the basis of physical parameters

There are different types of electric panel based upon their use area, materials used and principle functions. These classification enables systematical study of these panels.

In general observation, the metering panel can be classified according to following parameters:

a) The type of material:
   - insulating;
   - metallic;
   - combination of insulating and metallic;

b) method of fixing:
   - floor standing;
   - wall mounting;
   - flush mounting;
   - pole mounting;

c) the intended location:
   - outdoor;
   - indoor;

2.1.2 IP Classification of metering and degree of protection

IP stands for International Protection Rating or Ingress Protection Rating, which classifies or defines the level and type of protection and electrical enclosure has against outer hazardous or foreign particles. The IP code is "IP" word followed by two numbers (optional may be followed by two extra letter). These numbers identifies the type of protection it has.

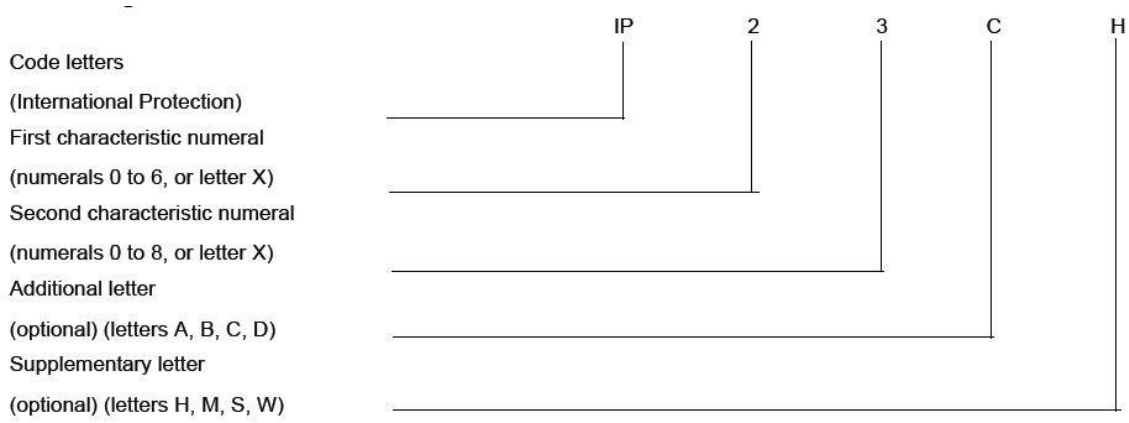


Figure 2 Arrangement of the IP code (Electrical-installation 2017).

The different combinations of numbers provides information about types of protection the panel has against foreign objects, as shown in table 1.

Table 1 Degree of protection identification (OriginalBTC 2017).

IP Ratings Table			
The first digit refers to the products Ingress Protection rating agaisnt solid particles and the second digit against liquid. IP XX			
Ingress of Solid Objects		Ingress of Liquids	
IP	Protected against	IP	Protected against
0	No protection.	0	No protection.
1	Solid objects over 50mm, e.g. hands, large tools etc.	1	Vertically falling drops of water or condensation. Limited ingress permitted.
2	Solid objects over 12.5mm, e.g. fingers, tools etc.	2	Falling drops of water when product tilted up to 15 degrees from vertical. Limited ingress permitted.
3	Solid objects over 2.5mm, e.g. rod, small tools etc.	3	Sprays of water at up to 60 degrees from the vertical. Limited ingress permitted.
4	Solid objects over 1.0mm, e.g. small wires.	4	Sprays of water from any direction. Limited ingress permitted.
5	Dust, limited ingress with no harmful deposit.	5	Jets of water from any direction. Limited ingress permitted.
6	Dust tight.	6	High pressure jets of water from any direction. Limited ingress permitted.
		7	Temporary immersion in water.
		8	Immersion in water, under pressure for long periods.

2.2 **Electromagnetic compatibility (EMC) requirements**

All electric device or installation influences each other when interconnected or kept near to each other. The electromagnetic compatibility study and research about the electronic product is required to mitigate or stop all the possible interferences.
The design of the metering panel should consider the electromagnetic compatibility of it and surrounding. With boom on electronic device and appliances from mid-20th century, we have been inventing numerous devices which sends some kinds of electromagnetic signal or message. This growing number of signals had created ample situation of interference of these signals between and among the devices. So broad sense of necessity of its regulation was discussed among the authorities after the end of World War II. (Emcfastpass 2016.)

EU standard IEC 61000 defines the requirements for Electromagnetic compatibility including for parts.
Besides the physical protection and mounting, the enclosure has following function related to electromagnetic compatibility:

- Providing a local earth reference for internal equipment

- Providing and demarcating a zone of increased EMC protection
- Providing radiated field coupling to and from the internal equipment.

Electromagnetic compatibility testing is conducted to ensure the electric or electronic device does not emit more electromagnetic interference than the maximum to ensure the proper function ability of it and the surrounding other devices. (Europa, 2017.)

2.3 **Manufacturing**

From the panel design to the market product, there are many steps during the manufacturing process of the electric cabinet. First of all the market request is valued and a panel is designed on 3D modelling software's. Design always considers all the norms and standard exist within the country and region of market. Then sheet metal lay out is created with detailed dimensioned 2 D drawing. CNC program code is created from the layout of sheet metal for punching and shearing. The work piece is put in the machine and CNC punching process is undertaken. Sharp edges are and some notched are grinded or filed. The punched and sheared part are bended to give the final shape of part of cabinet. Bending phase might take more time than similar other procedures, since some manual process are involved. After the mass production of many parts, the quality control is made. Defecated parts are removed from the stationary. Afterward, the parts are assembled by screw (in this product case) or welded (in some other cases) to give the frame of final electric cabinet. Second phase of quality control, which focus on the quality and dimension of the assembly product is undertaken. (Jason 2015.)

When all the mechanical process is finished, the electric components are assembled to sheet metal skeleton product. Different kind of electrical test are made to secure proper functioning and safety of the product.

3 THERORY AND FRAMEWORK

3.1 Panel EU standards

European Union is group of 28 European countries in Europe, formed to work together on economic, security and social agenda of continent.

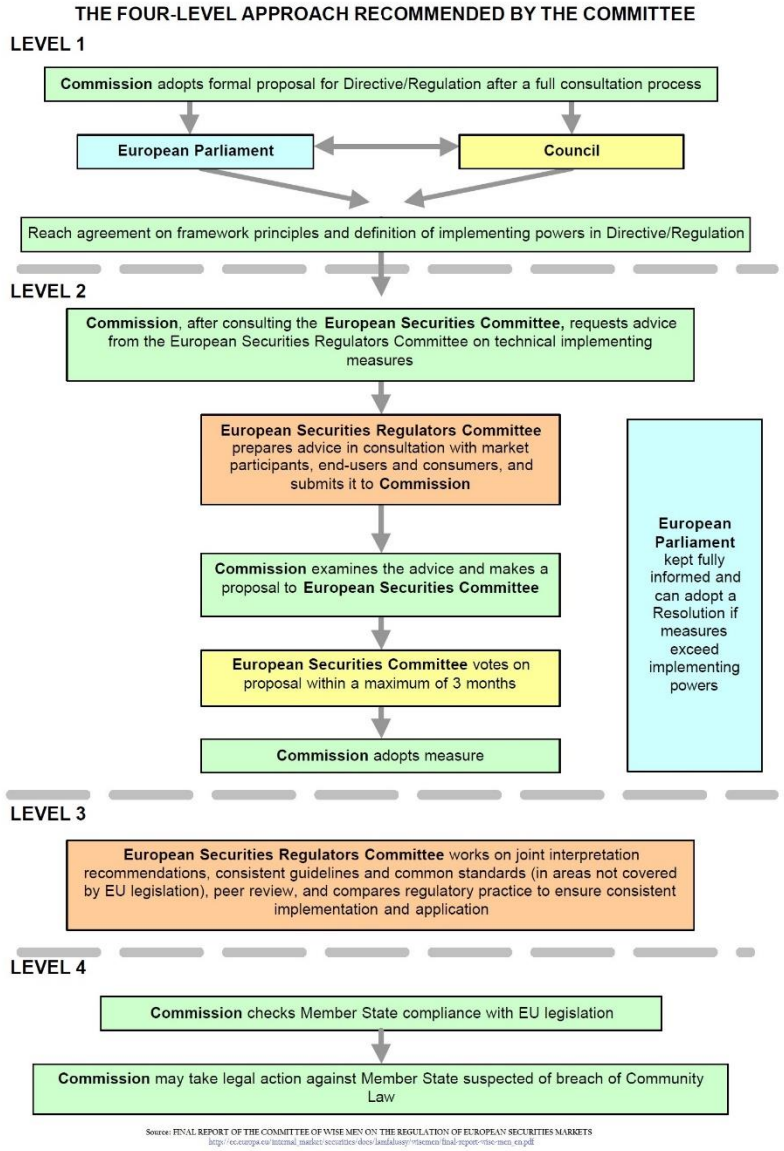


Figure 3 EU resolution implementation process (Write 2001).

The EU (European Union) parliament, which comprises the members from EU countries, legislates and executes the laws, regulations and standards. The entire product to be sold or used inside and among these counties have to act under these safety and standard. The member countries can bring the bills regarding potential economic, social and environmental impact and assessment activities or product. The bill is either decided on

consent or goes for voting on the EU council and parliament. Amendments on these bills can be made to get overall consents. The laws are adopted after the final procedure. (Europa 2017.)

So all the design we proposed in this project should comply all the existing laws and regulations of the European Union.

3.1.1 Clearance and creepage distances

To provide the insulation allotment within the electric product, any electronic product must follow the principle of Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests, IEC 60664-1. The main purpose of this principle is to provide proper clearance and creepage distance. The parts of product should comply with the standard of clearance and creepage distance so as the assembled product itself. (Suomen standardisoimisliitto SFS RY, 2013.)

3.1.2 Protection against electric shock

Low-voltage switchgear and controlgear assemblies – Part 1: General rules IEC 61439-1, 8.4.2 provides the specifics principles and standards to be followed during the production of low-voltage switch gear and control gear assemblies to prevent direct contact with live hazardous parts and to give protection against the shock. (Suomen standardisoimisliitto SFS RY, 2013.)

There shall not be uninsulated part on live part or line. Insulation should be made in a way that it can be only removed by tool or destruction of it.
Enclosure of products should follow IP classification against outer component. (Suomen standardisoimisliitto SFS RY, 2013.)

3.1.3 Incorporation of switching device and electric components

Low-voltage switchgear and controlgear assemblies – Part 1: General rules IEC 61439-1, 8.5 provides the specifics related to incorporation of switching device and electric components.
Voltage should be disconnected before applying part switching. Also after it, other standards like creepage and clearance distance should not be violated. (Suomen standardisoimisliitto SFS RY, 2013.)

3.1.4 Internal electric circuit and connections

Low-voltage switchgear and controlgear assemblies – Part 1: General rules IEC 61439-1, 8.6 provides specifies related to internal electric circuit and connections. There are two types of circuit as per their position and

functionality that are main and auxiliary circuits. (Suomen standardisoimisliitto SFS RY, 2013.)

3.1.5 Dielectric properties

Low-voltage switchgear and controlgear assemblies – Part 1: General rules IEC 61439-1, 8.6 provides specifies related to dielectric properties.
The circuit in the electric product should have withstanding capacity for temporary and transient overvoltage. (Suomen standardisoimisliitto SFS RY, 2013.)
Low-voltage switchgear and controlgear assemblies – Part 1: General rules

Power-frequency withstand voltage, impulse voltage and protection of surge protection devices are areas we should consider. (Suomen standardisoimisliitto SFS RY, 2013.)

3.2 **Design for manufacturability and assembly(DFMA) and cost Factor**

DMFA stands for design for manufacturability and assembly. It is the field of engineering which coordinates with concurrenting engineering for maximum productivity and quality of products.

One of the two major step of this process is design for manufacturability, which emphasis on the considerations and methods to improve manufacturability of a product. While designing, engineer should consider the manufacturing process and the factors that affects the manufacturability of a part, the cost minimization and product optimization. We know that most of the cost of a product development is spent in the designing and preparation phase. Thus, a brief consideration of this technique will not only make the product inexpensive, qualitative and easy to manufacture but also the time to launch the product will decrease significantly. The process will help to create a monopoly in the market. (gatech Nd.)

Similarly, the design for assembly teaches about the considerations that should be taken into account during the design of the product so that the components of a product are easy to assemble, the overall quality is improved and the strength of the product is maintained or enhanced. (gatech Nd.)

We follow the principles of concurrent engineering to achieve the goals of DFMA which means that different processes in production are run simultaneously rather than as a step by step separate process. While doing this, the designer and other departments of production can coordinate and improve the design before it really becomes a product. This enables the

minimization of recalling and redesigning the product after it has been sent to the production line

3.2.1 Design guideline for shearing

There are many basic design guidelines that have to be kept in mind when making sheet metal shearing. As referenced from Tapio Vaisanen lecture 2016, the following shearing points should be considered during design

- Holes should be designed circular rather than rectangular or other polynomial shape.
- Standard sizes of hole should be used in design. This makes easier to find right tools and proper counterparts.
- There should be minimum length between edges and holes. The standard method is minimum distance > 2* t (t = thickness of sheet)
- Narrow projections and cutouts should be avoided (width> 3*t)
- The dimensions should be made considering the standard stock material size to make maximum profit out of it
- The minimum distance between two extruded holes must be six times the material thickness
- Unlike holes, slots should be punched after the bending. So there must be enough space between bending corner and slot so that there are no distortions and shearing.

3.2.2 Design guideline for bending

There are many basic design guidelines to keep in mind while making sheet metal bending. As referenced from Tapio Vaisanen lecture 2016, the following bending points should be considered during design.

- Minimum bending radius is function of type of material. So bendability of material should be considered while making bending.
- Bending should be done in perpendicular to the direction of rolling.
- Small bending flange should be avoided for bigger sheet metal parts
- Stress concentration on bending part should be removed. Usually with notch.
- Bending should be avoided near hole or slots. Or hole should be avoided near bending areas.
- While making bending, the flange size must be at least four times to the thickness of sheet metal.
- Bending radius is very important factor. It should be at least 0.8 mm or half the thickness if sheet metal are thicker than 1.5mm. This factor is more critical
- Bending angle can be varied as per the design but obtuse angle should be avoided.

3.3 **Optimization, safety and size factor**

3.3.1 Size or volume factor

The size of the metering cabinet plays a major role as to market popularity and market value. These factors are heighted when the cabinet has to be installed on larger buildings with narrow passages.
Thus minimizing volume (Size) without altering the quality and breaking standards are the biggest working area.

We Know,
Volume (V) = Length (L) * Breadth (b) * Height (H)

When we keep Length and breadth constant

Volume α Height

So we can change the volume of the cabinet by changing the height of the panel while keeping the length and breadth constant.

3.3.2 Cost factor

The market value of the product is undeniably the biggest factor for the company. A slight change in price can be major factor in marketing it to the costumers. Among different manufacturing costs, the cost of material has a major role. Though the electric components cannot be altered on a specific model of a metering panel, sheet metal raw material can be altered which will change the cost of price.

We know:
Price of material (P) = Weight of sheet metal part (W) * Cost per kg
= Volume (V) * Density of material (D) * Cost per Kg

When the same material is used at the same per kg price:

Total Price α Volume (V)

Thus the cost of the product increases with an increase in volume. So, we can decrease the space occupied by the product as well as the cost of production by decreasing the height of it.

3.3.3 Safety factors

The safety of the user and the personnel manufacturing the products is a vital aim as to the safety factors. We always put human safety in front of everything.

In this design, safety factors required by the European Union as well as the national governing bodies were followed.

Suomen Standardisoimisliitto SFS ry is Finnish standard regulating body. It is a member of International standard organization (ISO) and European organization for standards (CEN). SFS updates and announces thousands of standards annually with a reference from International standard organization (ISO) and European organization for standards (CEN). (Wikipedia 2017).

3.4 **Technical documentation**

In broad term, Technical documentation is any of the written or depicted file or document with user description, operation manual, or description of how to handle an operation or a product. In electronic product term, it is also commonly called manual. However, in engineering term, it's meaning converses to technical drawing for individual piece and its final assembled product. (Transcom Nd.)

3.4.1 Basic symbol and attribution on technical drawing

There are many lines and symbols used in the technical documentation to give the many terms, which are possible to mention on it with texts. According to St Rosemary Institution 2010-2017, the basic line terminology used in technical drawing are:

- Construction Line: They are represented by thin black line which are used to give layout the drawing
- Dimensional line: They represented by thin black line with arrowhead on it. The main purpose of this line is to represent the dimension of the length or dimension they notified
- Hidden Line: These lines are represented by dash of medium thick lines, which are used to show invisible surfaces.
- Center Line: These are dash line of long and short lines, which represents the center axis of hole or circle or axes.
- Extension line: These lines are used to show the start and end of the dimensions. They are represented by think black line extended from near surface of drawing of product.
- Break Line: When the dimension of one side of product is very long, its exact representation is sometime impossible in technical drawing. These are represented by break line.

- Leader Line: They are single arrow headline used to add note or represent the part with other symbols.

- Section Line: Mostly slanted line with dot, are used to show the surface is sectioned in that part.

- Section View: In drawing of some complex object, the interior part is difficult to be shown from outer view drawing. So the object are cut with imaginary section axis to present drawing when looked from inside.

- Isometric projection: It is the projection of 3D view of the object in 2D drawing. These views are also presented in drawing with other views (front, back, side, top, down) to enable view to mage 3D imagination of product quickly in their head.

3.4.2 Tolerance in design and measurement

Engineering tolerance is the limit of accepted variation for dimension, form, orientation, location and run out. In engineering drawing, either the individual tolerance are provided or geometrical tolerance are given which usually covers the whole tolerances. There are many causes of errors during measurement which could be very difficult to avoid. If these errors are not acknowledged in drawing, the product made by following that drawing can have issues during use or assemblies (Wikipedia 2017).

These major errors on engineering measurement can be classified into two parts.

- Random Errors
  Random errors, also called statistical errors are error caused by unknown or unpredictable source during measurements.
  For an example; you might get the reading of a length 17.1 mm and on a next measurement, it might be 17.4 despite the fact you used same instrument and process to measure the same length.
  These kind of error can be reduced by taking several measurement and taking its mean value. (umdphysics Nd.)

- Systematic Errors
  Systematic errors, also called biased error are errors on measurement caused by the faulty measurement instrument, process, environmental factors and skill of the person handling it.
  For example; the measurement might show 17.1mm due to slight elongation of measuring tape over a long use, although the real value of measurement is 17.5mm.

> These kind of error cannot be reduced by multiple sample measurement. It should be detected by human observations on data and taking reference from other instrument or environment. (umdphysics Nd.)

There are different standards to counterbalance these errors in a way it does not affects the part use or assembly. Geometric ISO 2768 tolerance is most standard and widely accepted system to be used in technical drawing for wide verities of drawing. This standard is also classified in to Fine (F), Medium (M), Coarse(C) and Very Coarse (C) as per the allowable deviation in dimension.

The table below gives tolerance range for different classification of tolerance and nominal lengths.

Table 2 General tolerance for linear dimensions (hastaymakina Nd).

LINEAR DIMENSIONS:

Permissible deviations in mm for ranges in nominal lengths	f (fine)	Tolerance class designation (description)		v (very coarse)
		m (medium)	c (coarse)	
0.5 up to 3	±0.05	±0.1	±0.2	-
over 3 up to 6	±0.05	±0.1	±0.3	±0.5
over 6 up to 30	±0.1	±0.2	±0.5	±1.0
over 30 up to 120	±0.15	±0.3	±0.8	±1.5
over 120 up to 400	±0.2	±0.5	±1.2	±2.5
over 400 up to 1000	±0.3	±0.8	±2.0	±4.0
over 1000 up to 2000	±0.5	±1.2	±3.0	±6.0
over 2000 up to 4000	-	±2.0	±4.0	±8.0

Also, there are some other standards like, DIN 6930, which gives the general tolerance for the cut, bended, deep drawn or any other rolled plate or sheet metals parts. Similarly, DIN 6935 standard gives the definition for bending radius and dimensions of unfolded sheet metal parts.

3.4.3 Visible surface

The visible surface are the part of the product, which are first seen on the product. Usually these areas provides the eye-catching sense to costumers. So the visible surface are represented on the technical documentation. This will help the manufacturer identify the visible surface and hence protect it from scratch and deform during manufacturing steps like bending, forming, shearing. (Karppa 2017, Lecture Note.)

4 METHODOLOGY

The first step of thesis was to prepare full-scale technical drawing for the special pieces of metering panel. All the measurement of those parts were required in order to do that. So, frequent visit of the company were made. Afterward, the focus was given for assembled part of metering panel. Couple of meetings were held in between to overview the current progress and direction to take going forward. Some initial plan were changed/deviated when thesis process went forward. Same methodology were used to mount the destination of designing new metering panel and its technical drawing.

PTC Creo paramatic 2.0 software was used to create all the drawing throughout the thesis while measurements of the parts were taken with a Vernier caliper and measuring tape.

5 OVERVIEW OF PRODUCTS AND THESIS ACTIVITIES

5.1 Current model of metering panel

There are many varieties of metering and other electrical cabinet being sold by the company XYZ. The word “current model of metering panel” is specifically used for the model of metering panel we are working with.
This metering panel is indoor metering panel with IP classification of “IP 20” which are used in the residential building to measure the amount of electricity consumed by individual apartment at designated period of the time. The general height of them are 2 meter with varieties of breadth depending on the model of a panel. The number of meter a panel can holds depending up to their model, ranging from 3 to 9.

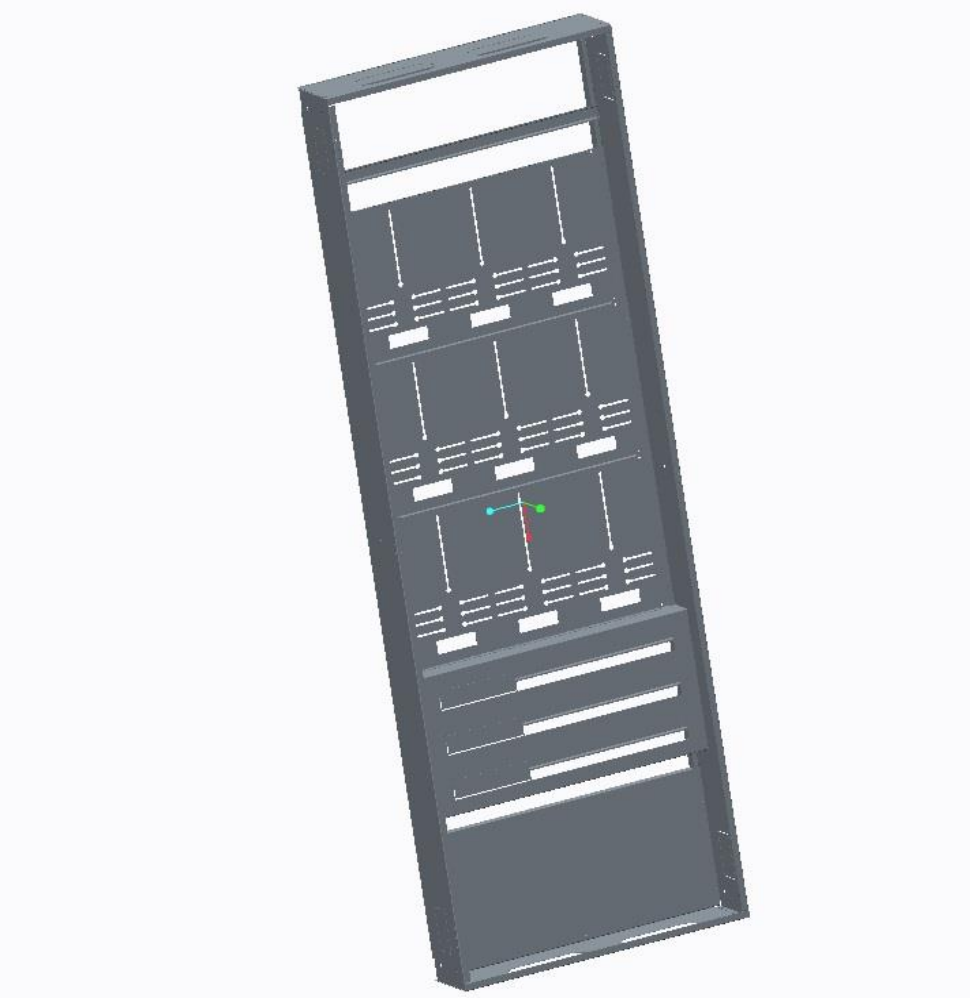


Figure 4: three dimensional model of frame of current panel model

5.1.1 Layout of the panel

In the company XYZ, the number of the meter that can be used on it distinguishes the models of the metering panel. These meters are held on special part of the panel named “Meter Holder”. The number of meter one holder can hold also depends upon its breadth. Different combination of meter holder are made as per the necessity of the number of apartment or supply that are made through that panel.

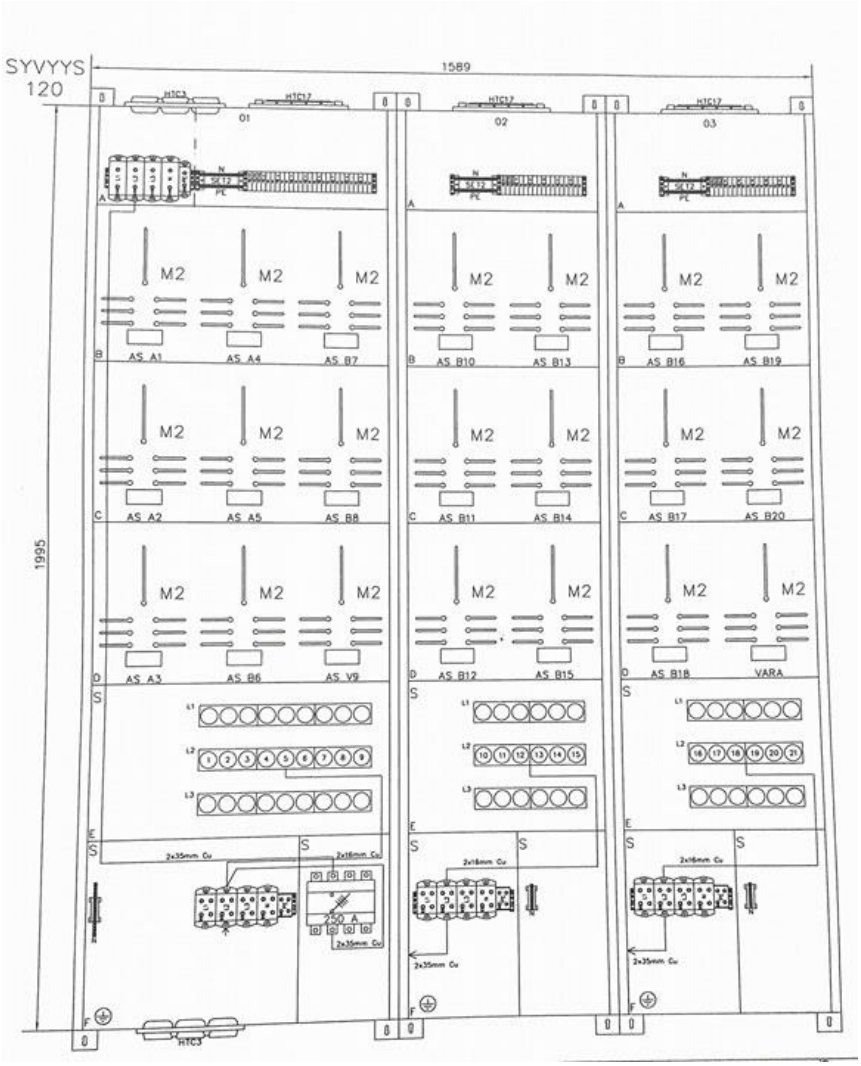


Figure 5: Layout of one kind of current metering panel.

In this layout, there are incoming and outgoing wiring from bottom and top of the panels. The wiring are made through holes with rubber cable gland protection.

5.1.2 Components of the panel

There are basic 6 component on the frame of panel which acts as a skeleton of the panel. There are few more components which are incorporated with the panel frame to give final product. These parts on any metering panel model are modular to components of other models. This allows manufcturing process easy, quick and economical since same set of tools and machine can be used to manufacutre any model of panels.

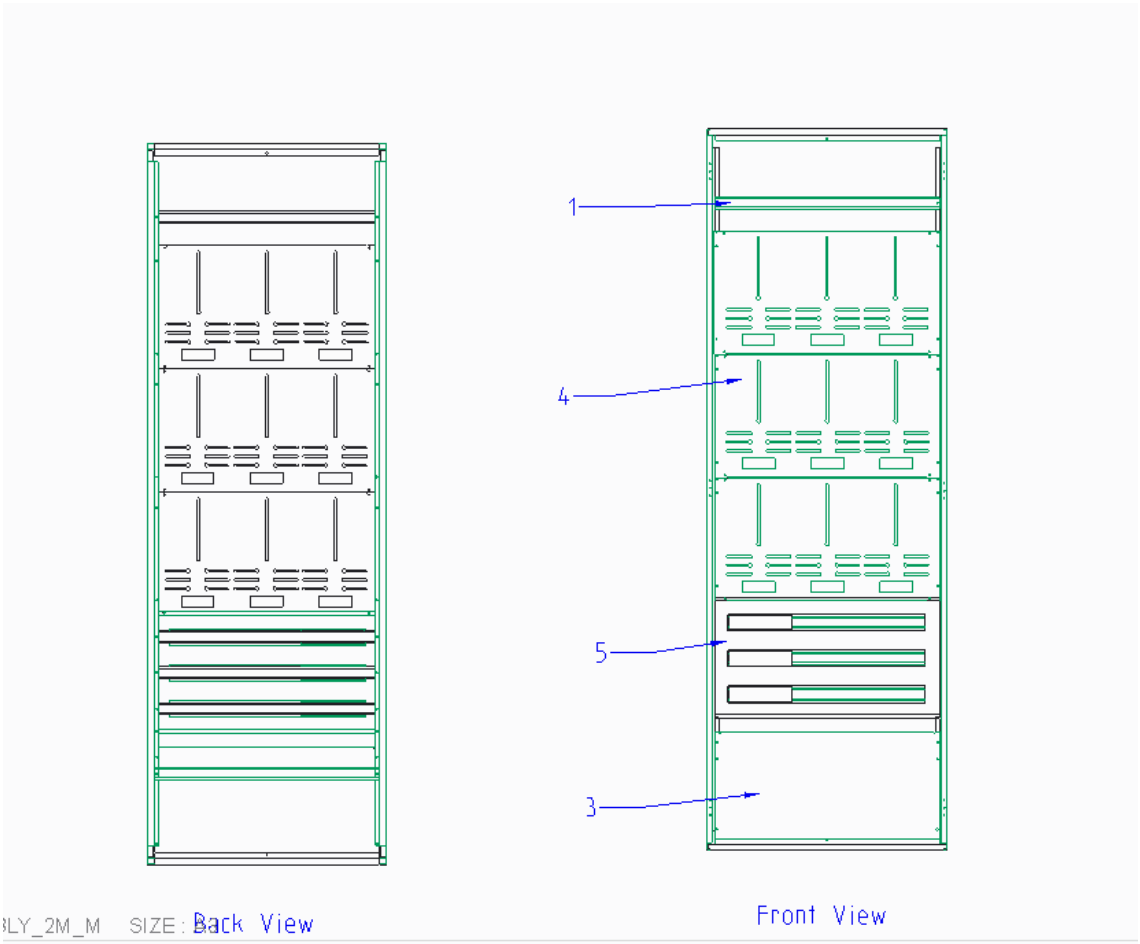


Figure 6: Technical drawing for assembly of meter panel.

Table 3 Contain of panel frame.

Number	Name of the part	No of parts in one panel
1	Holding bar	6
2	Top cap cover	2
3	MI10055	1
4	Meter holder	3
5	Three holed piece	1
6	Side Cover	2

These major components have specific function on the product.

- Meter Holder
  Meter holder is the component of frame which holds the meters that records data of electrical energy consumed of individual circuit that goes to individual apartment or electricity customers.
  The size or model of meter holders designates the model of the panel. The primary focus of the project is to expand the capacity of this part so that more record of apartments can be made by one panel model.

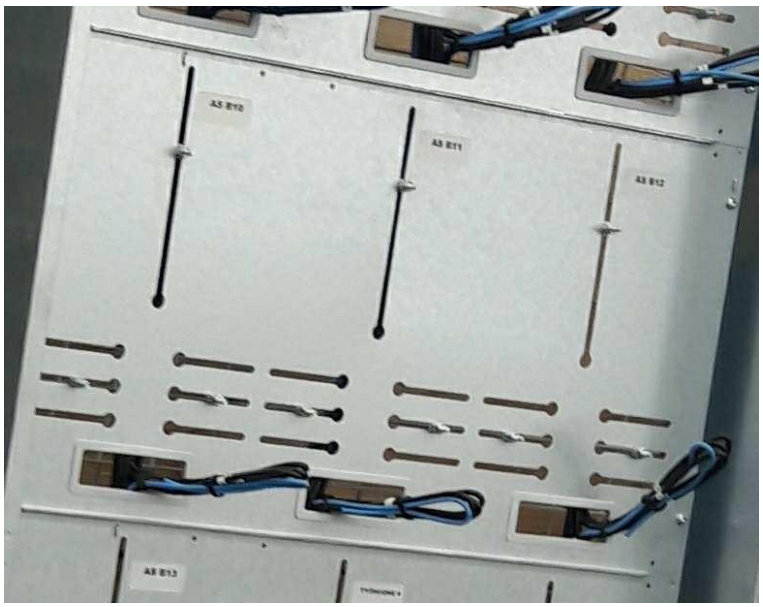


Figure 7: Meter holder in an electric pane.

- Holding bars
  Holding bars give support and hold the other parts containing electrical components.

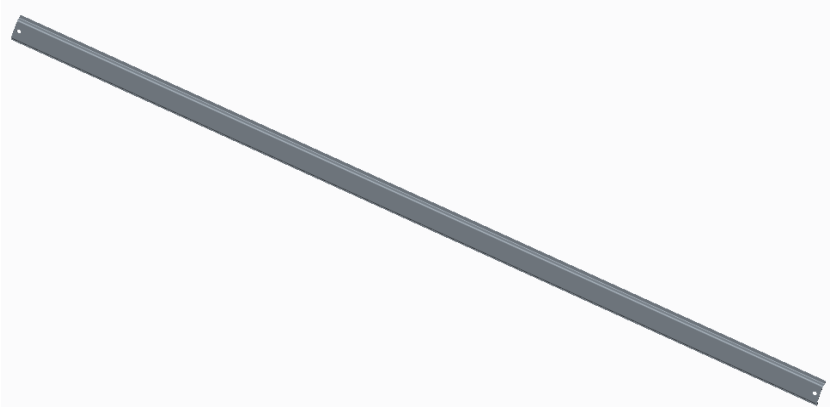


Figure 8: Three dimensional picture of a holding bar.

- Three hole piece
  The distribution grid and other electric components are held here in this part of the panel.

Figure 9: Three hole piece in a metering panel.

- MI10055
  This component configures some of the electric parts and incoming wiring.

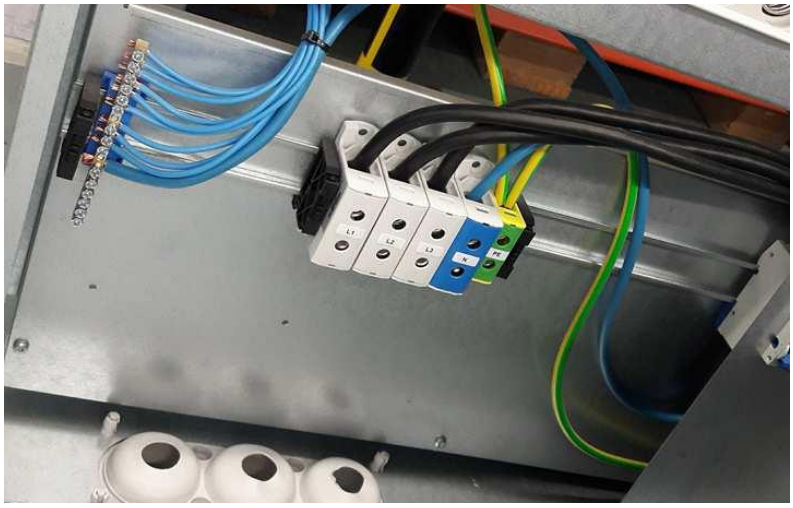


Figure 10: MI10055 in electric panel.

- Top cap cover
  These are top and bottom cover of the panel. It gives protection to interior and also has the holes for all incoming and outgoing electrical wiring.

Figure 11: Top cap cover on electric panel.

- Side cover
  These are long cover of sheet metal bar which held two end of other component horizontally. It also gives the protection to interior parts from side.

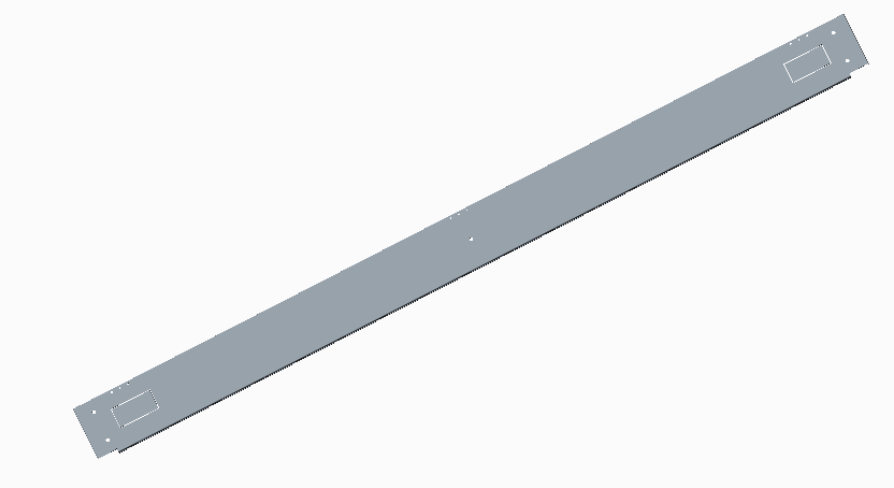


Figure 12: Three dimensional picture of side cover.

Most of screws used on the panel is M5 screw. So, holes are punch on each sides of parts to hold it to frame has holes of diameter 5 mm.
But there are few holes inside other components of panel which has different diameter (usually 9 mm and n11mm).

5.1.3 Downside of current design

This thesis is part of development project of the company XYZ. The features which are being revised might not have total downside but optimizing of those feature can assist for better product.
The size of current panel is huge and still lacks enough space for many meter holders in some cases. In current model, the maximum number of meter it can include are 9. Some layout has even smaller in number. These kind of layout can be good enough for small housing building but for house with higher number of apartment, it can be an issue. The height of the panel is another area where improvement is necessary. Current panel are taller than 2 meters which might be too tall to transport and install the panel. Since, more the size of product, higher the raw materials required. The current product has two door which are connected by hinge to main part. The meeting with company representative proposed the new simpler solution for it.

5.2 **New modification of the panel**

The new layout of the metering panel was proposed by the company decision body. The product will be under same IP classification as it used to be previously.
New model has been modified to decrease the size of model significantly while increasing the number of meter holder it can hold. Doors are simplified as per previous proposal.

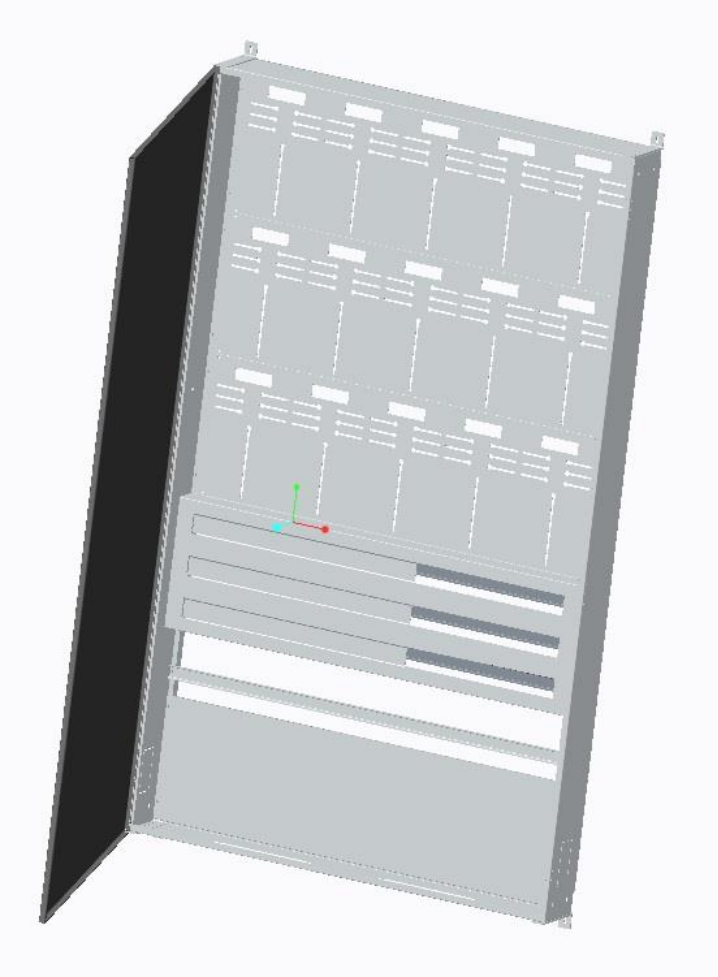


Figure 13 New design for one of model of metering panel.

5.2.1 Layout of the model

The current model (layout) can hold up to 15 meter in one of part which is almost double than previous maximum (9 meters). All of electrical control and safety components are located (shifted) to lower part of panel. All the incoming and outgoing wiring are made from below of the panel which allows the repair and control technicians to focus on singular area.

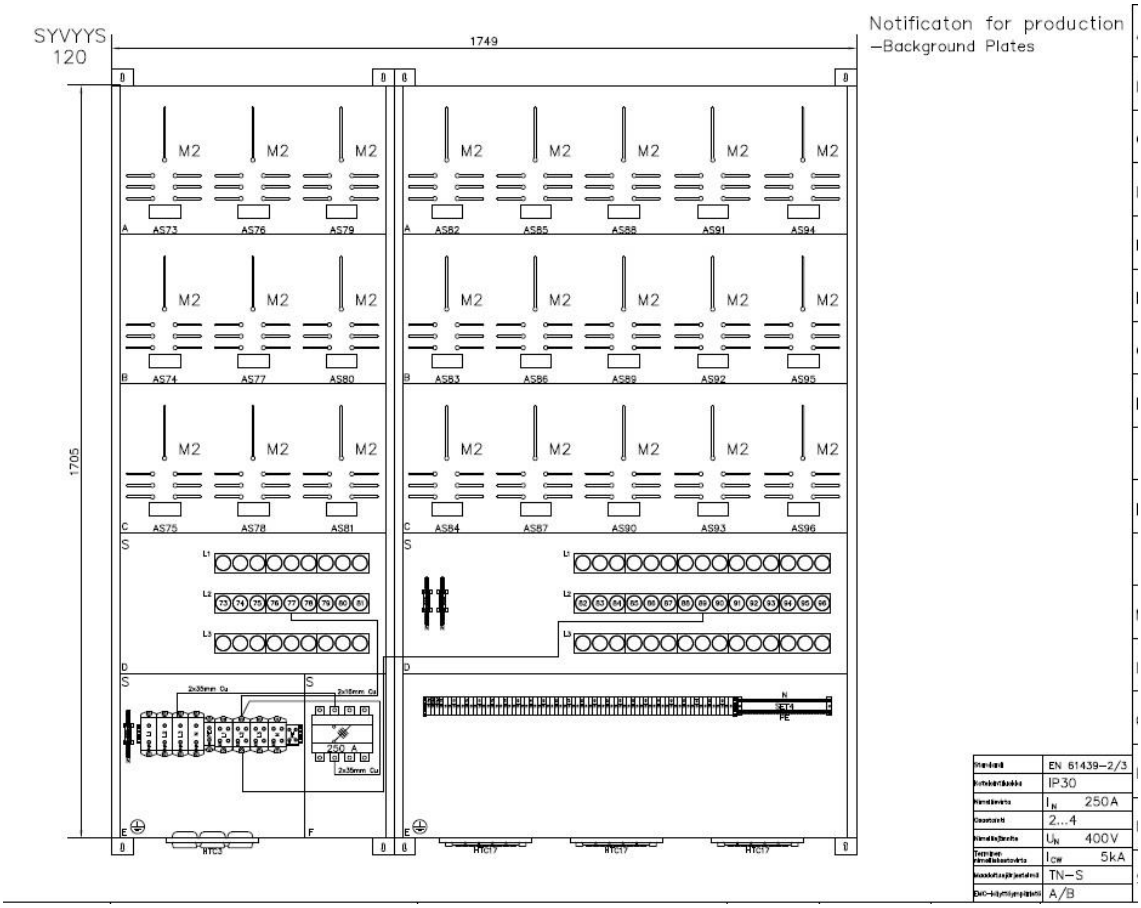


Figure 14: New proposed layout of the metering panel.

There are three major pathways (holes) in the panel to ensure enough space for all the incoming and outgoing wire systems unlike the previous two holes system.
The power switches, emergency breaks and all the electronic components are to be fit on the lower part. It will help technician to repair and assemble the panel.

5.2.2 Components of panel

New components of the electrical panel were designed in the modularity of the older design. The components are to be made by same manufacturing process with slight change in dimensions. It will save manufacturing time by removing the need of changing types of machine and tools. In addition, limited number of machine can perform all the manufacturing process.

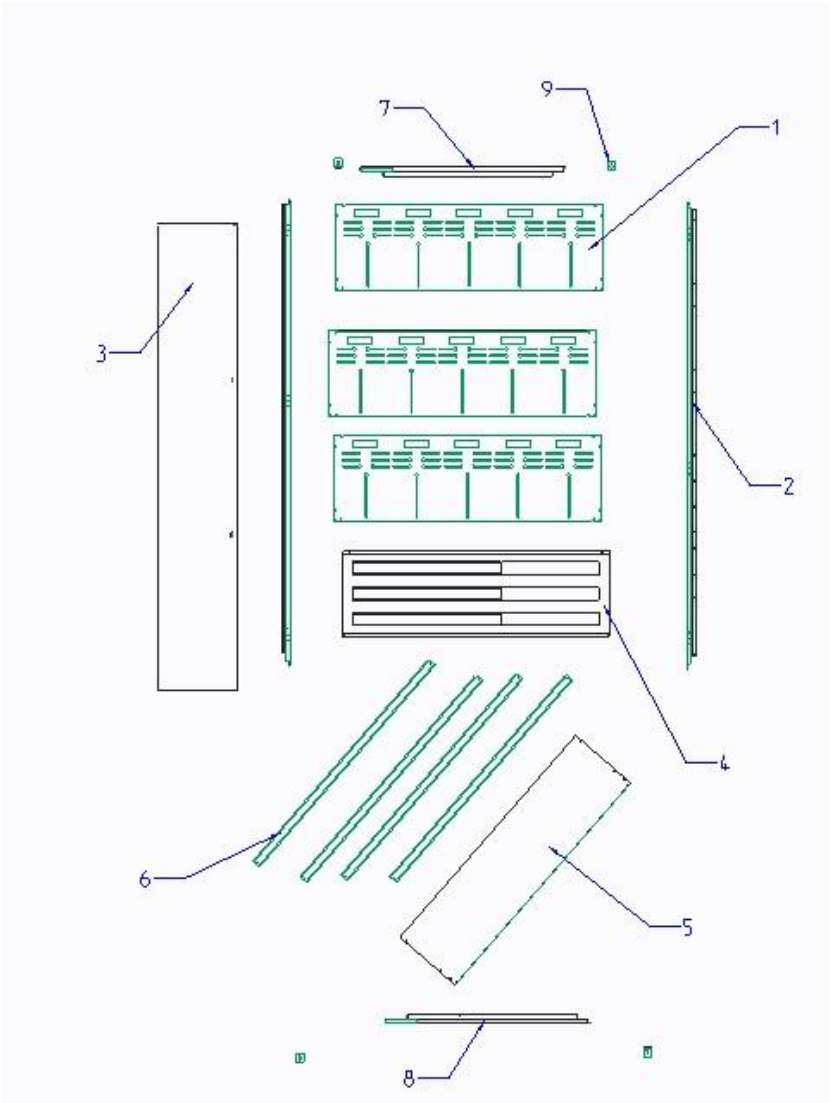


Figure 15. Components of new panel design.

The components illustrated in figure 15 are modular to the previous design. So the names of the parts are similar.

The Table 4 below will illustrate the name and number of components used in the new design

Table 4 Components of designs and number of pieces.

Numbers	Name of the parts	No of piece per part
1	Meter Holder	3
2	Side Cover	2
3	Door	1
4	Three holed part	1
5	MI10055	1
6	Holding rods	4
7	Top Cover	1
8	Bottom cover	1
9	Connectors	4

5.2.3 Optimising

A major working part of the work in the project was to optimize the capacity of the meter while managing the size. Meanwhile few modifications were made while designing the door parts and system of its wiring.
The Table 5 below shows the comparison between old design and new purposed design.

Table 5 Comparison between old and new design.

Parameters	Old layout panel	New layout panel
Max numbers meters in one part	3*3 = 9	5*3=9
Height	Over 2 meters	1.75 meters
Door	Double part/flip	Single simple door
Wiring	Both from top and bottom	All from bottom

6 CONCULUSION

This thesis project took more than three months (with extra 3 months of absence). The major area of work was creating technical documentation for the current design of electrical cabinet supplied by the company and working on the new design for the proposed layout of a new product. Some proposals about extra features were introduced. Some of them were considered while some could not be taken into consideration due to the time frame and other design restrictions.

The measurements for the initial drawings were made on site at company with a measuring tap, Vernier calipers and an angle meter. The tolerance in measurement was 0.5 millimeters but later this was converted into ISO 2768-m. In spite of the best effort to achieve perfect dimensions, there could be minor measuring errors since the measurements were made from mechanically bent and worked parts. The error percentage might increase at smaller dimensions near mechanical action areas. The geometric tolerance ISO 2768-m will cover all the potential systematic and random errors made during measurements.

Another main part of the thesis project was to develop a design from the proposed layout. The designs were made on PTC CREO 3D drawing software and 2D drawings were developed from it. The design meets all the EU standards and guidance formulated by EU and implemented by Suomen standardisoimisliitto SFS RY. New single cover door design is included with option for commercially available cam locks.

During the process of the thesis project, the author acquired a lot of learning on sheet metal drawing, its standards and practical manufacturing points. This project will benefit the company with its development projects. The well prepared documentation of parts and design will be helpful for manufacturing and in the data recording process of the company.

REFERENCES

[A] Accuenergy 2016, Application: Panel Metering
https://www.accuenergy.com/page/support/application-panel-metering
Referenced 13.6.2017

[B] Emcfastpass 2016, A beginners guide to EMC
http://www.emcfastpass.com/emc-testing-beginners-guide/
Referenced 11.6.2017

[C] Europa 2017, Electromagnetic Compatibility directives
http://ec.europa.eu/growth/sectors/electrical-engineering/emc-directive_fi

[D] Jason 2015, Sheet metal parts HOW ITS MADE (B&B Manufacturing)
https://www.youtube.com/watch?v=5YUMC-1jj7U
Referenced 10.6.2017

[E] Europa 2017, How EU decisions are made
https://europa.eu/european-union/eu-law/decision-making/procedures_en
Referenced 21.6.2017

[F] Wright 2001, FINAL REPORT OF THE COMMITTEE OF WISE MEN ON THE REGULATION OF EUROPEAN SECURITIES MARKETS
http://ec.europa.eu/internal_market/securities/docs/lamfalussy/wisemen/final-report-wise-men_en.pdf
Referenced 17.6.2017

[G] SFS-EN 61439-1, 2, 3, 4, 5: 2013.05.06
Helsinki: Finnish Standard Associations
Referenced 3.5.2017

[H] IP 20 standard: 1987.10.19
Helsinki: Finnish Standard Associations
Referenced 3.5.2017

[I] SFS-EN 62208: 2012.10.08
Helsinki: Finnish Standard Associations
Referenced 3.5.2017

[J] SFS-EN 62262: 2011.08.15
Helsinki: Finnish Standard Associations
Referenced 3.2.2017

[K] Gatech Nd, Introduction to design for (cost effective) for assembly and manufacturing
http://me.gatech.edu/files/capstone/L071ME4182DFA
Referenced 14.4.2017

[L] SFS Nd, Suomen Standardisoimisliitto SFS ry
https://www.sfs.fi/
Referenced 18.4.2017

[M] St Rosemary Institution 2010-2017, Technical drawing and alphabet of line
https://schoolworkhelper.net/technical-drawing-alphabet-of-line/
Referenced 17.6.2017

[N] Umdphysics Nd, Random vs systematic error
https://www.physics.umd.edu/courses/Phys276/Hill/Information/Notes/ErrorAnalysis.html
Referenced 17.6.2017

[O] hastaymakina Nd, General tolerance to DIN ISO 2768
http://hastaymakina.com/pdf/genel-boyut-toleranslari.pdf
Referenced 21.6.2017

[P] OriginalBTC 2017, IP rating table
https://uk.originalbtc.com/images/faq-ip-rating-table-oz2am2.jpg
Referenced 21.6.2017

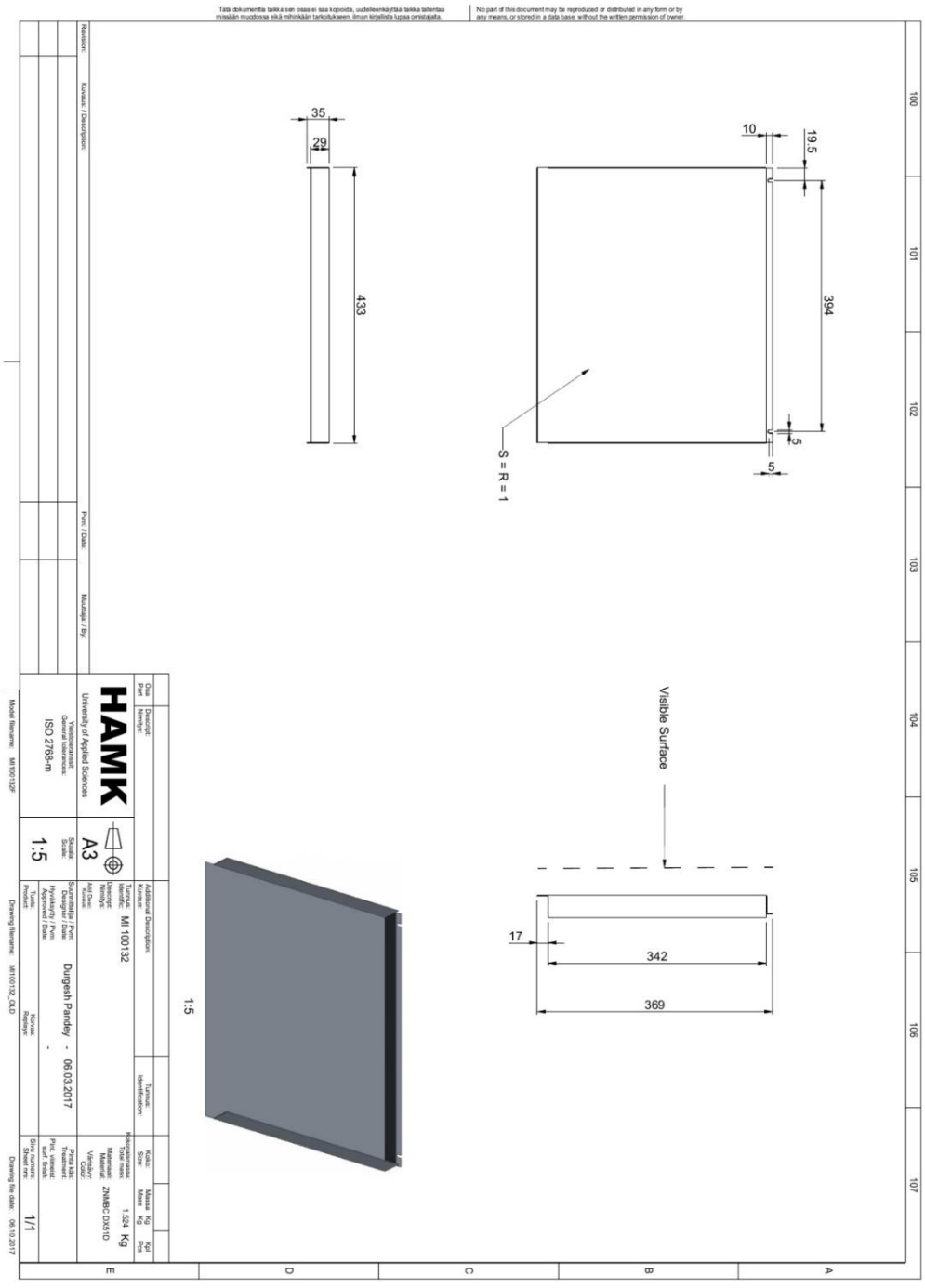
[Q] Electrical-installation 2017, IP code definition
http://www.electricalinstallation.org/enw/images/thumb/2/26/DB422199_EN.svg/356px-DB422199_EN.svg.png
Referenced 21.6.2017

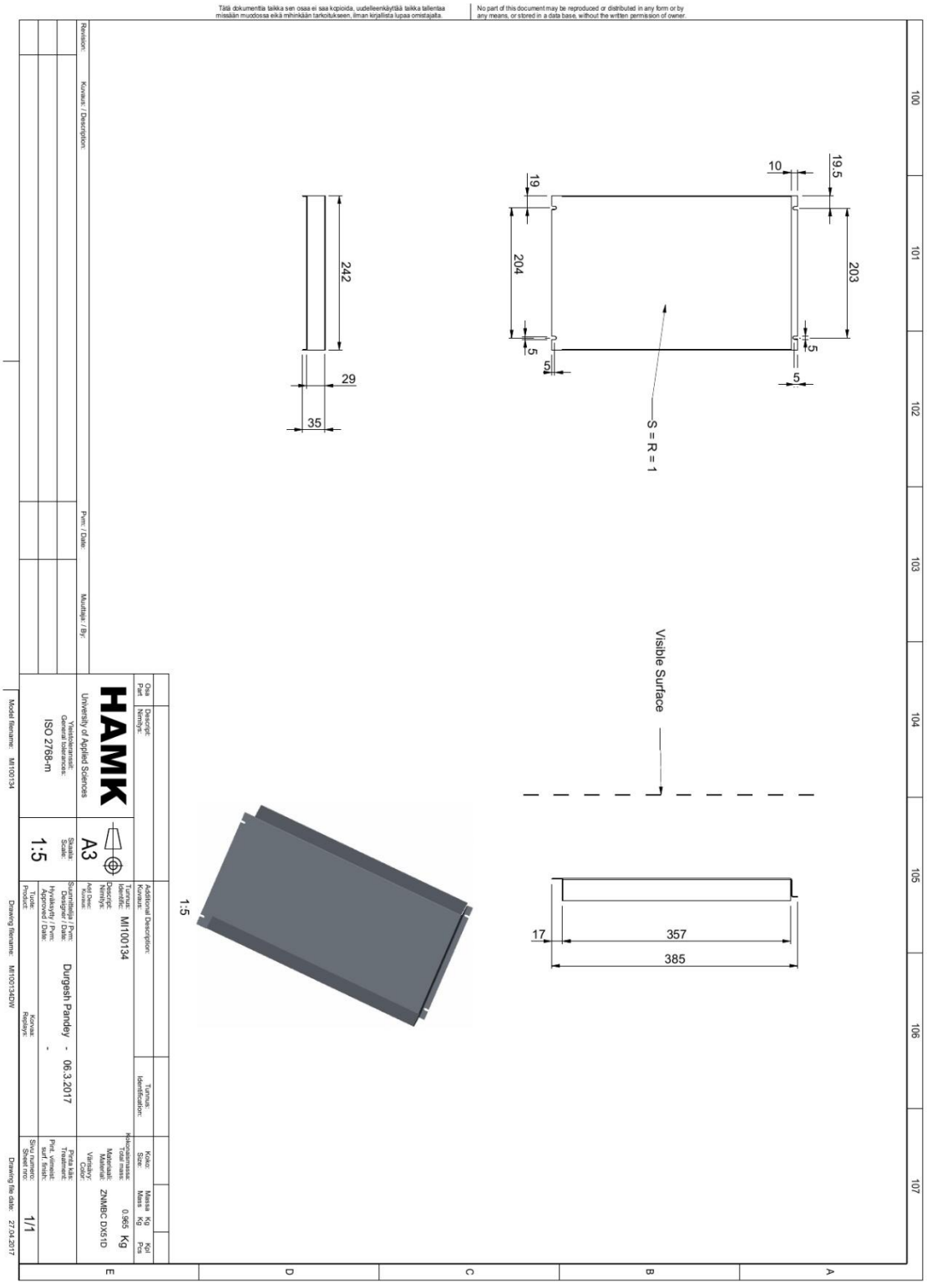
[R] Vvsystem 2013, metering panels
http://vvsystems.net/images/products/gallery/05_Metering_Panel/04_L.jpg
Referenced 25.6.2017

[S] Transcom Nd, What is “Technical documentation”?
http://www.transcom.de/transcom/en/technische-dokumentation.htm
Referenced 24.6.2017

APPENDIXS

Appendix 1 Important parts of current metering panel

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Tunnus:
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Nimitys:
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Muu tieto:
Kuvaus:
Suunnittelija / Pvm:
Designer / Date:
Durgesh Pandey - 06.3.2017
Hyväksyjä / Pvm:
Approved / Date:
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Korvaa:
Replaces
Tunnus:
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Size:
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Materiaali:
Material:
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Värisävy:
Color:
Pinta käs:
Treatment:
Pinta laatu:
Surf. finish:
Sivu numero:
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Pcs
Massa / Kg
Mass / Kg
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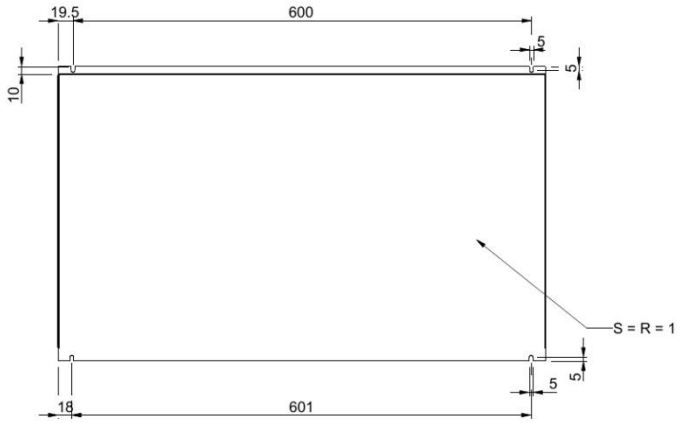

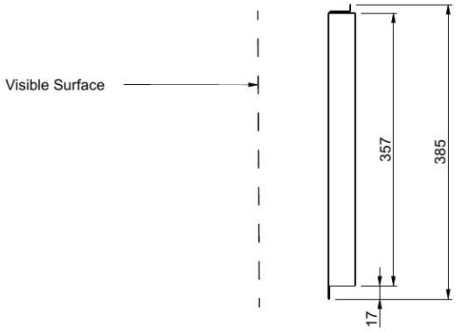

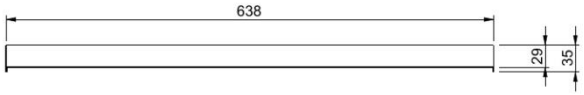

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Yleistoleranssit: / General tolerances:			Suunnittelija / Pvm: / Designer / Date:	Durgesh Pandey - 06.3.2017		Pinta käs: / Treatment:		
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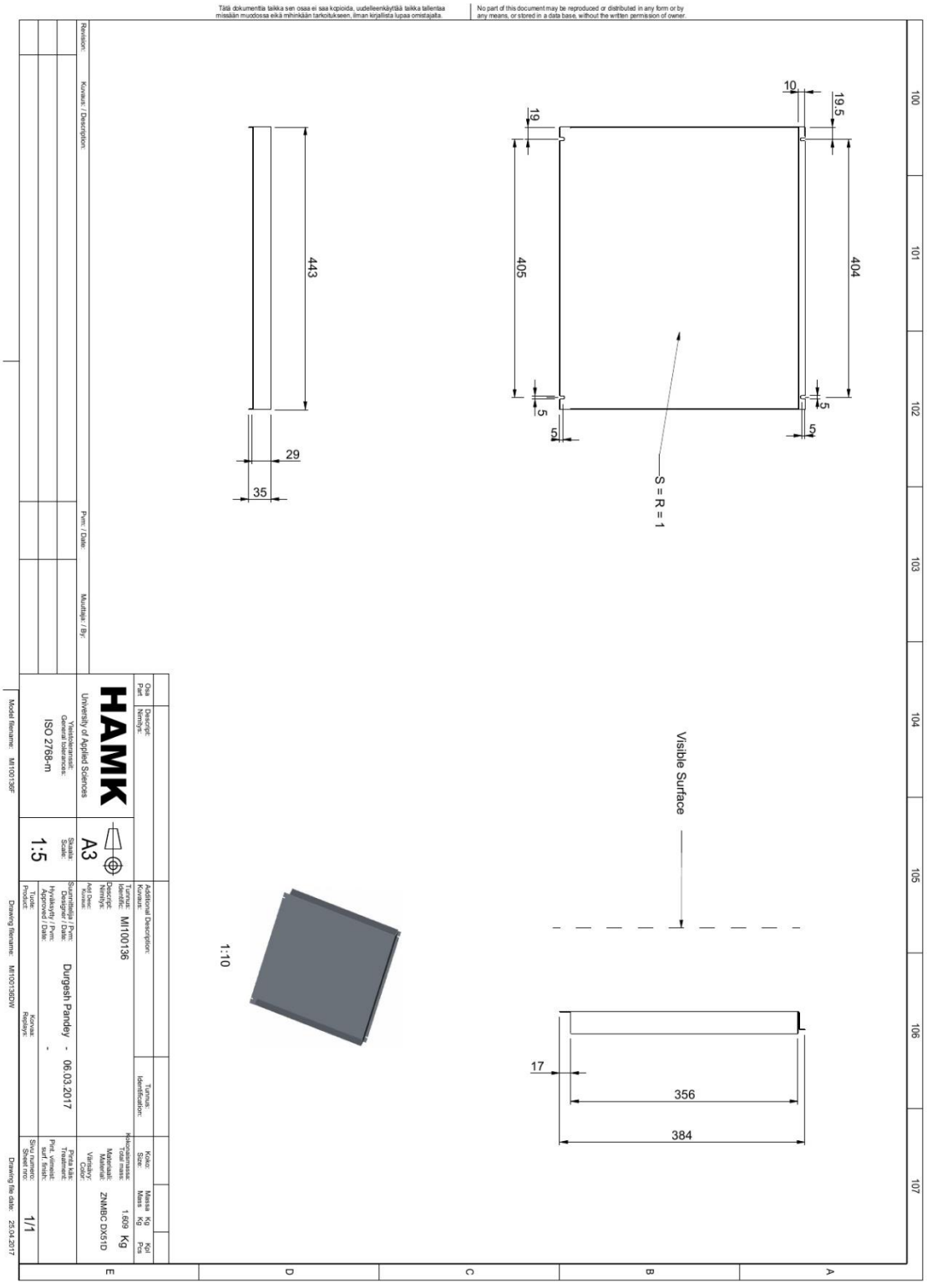
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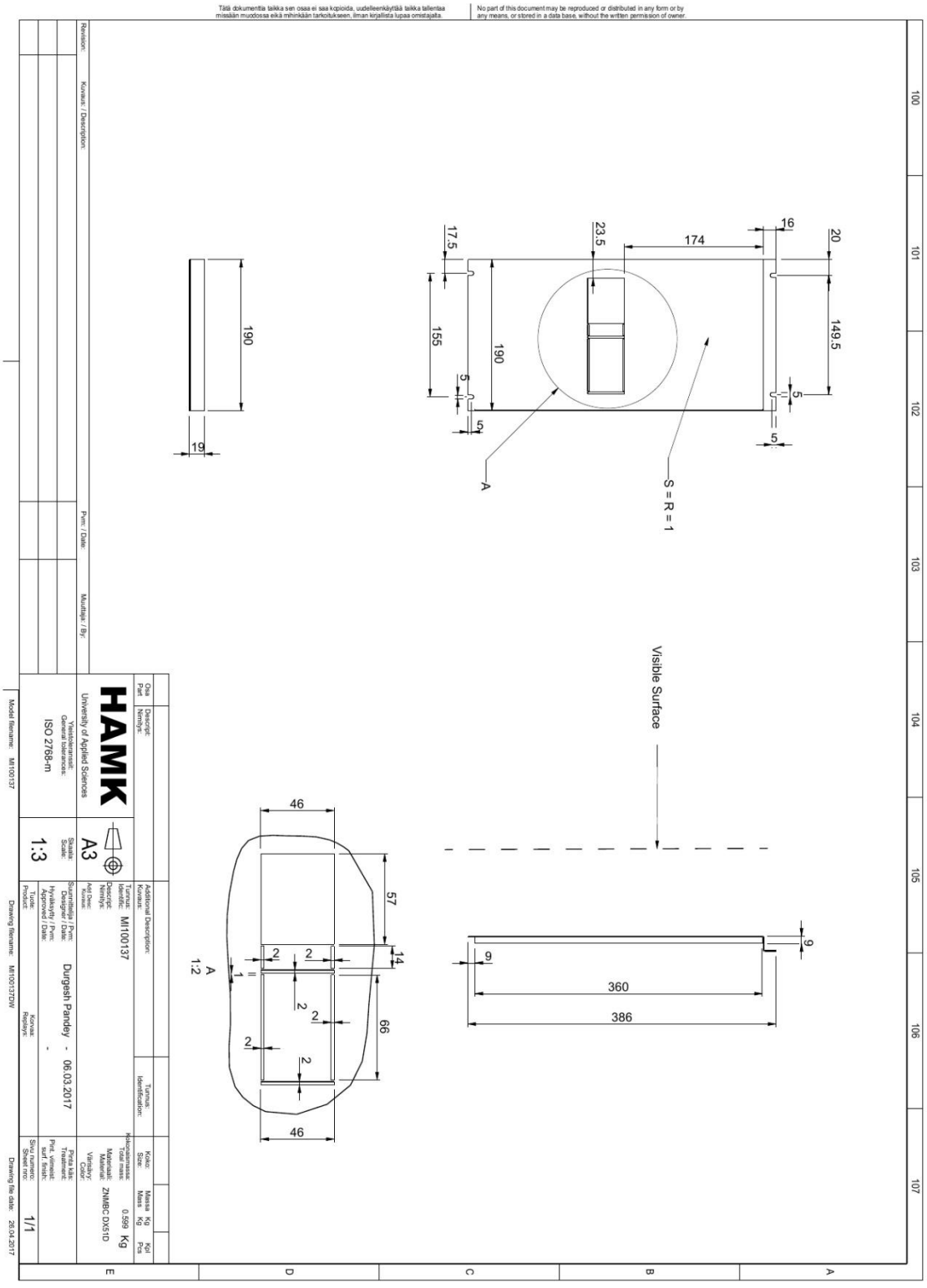
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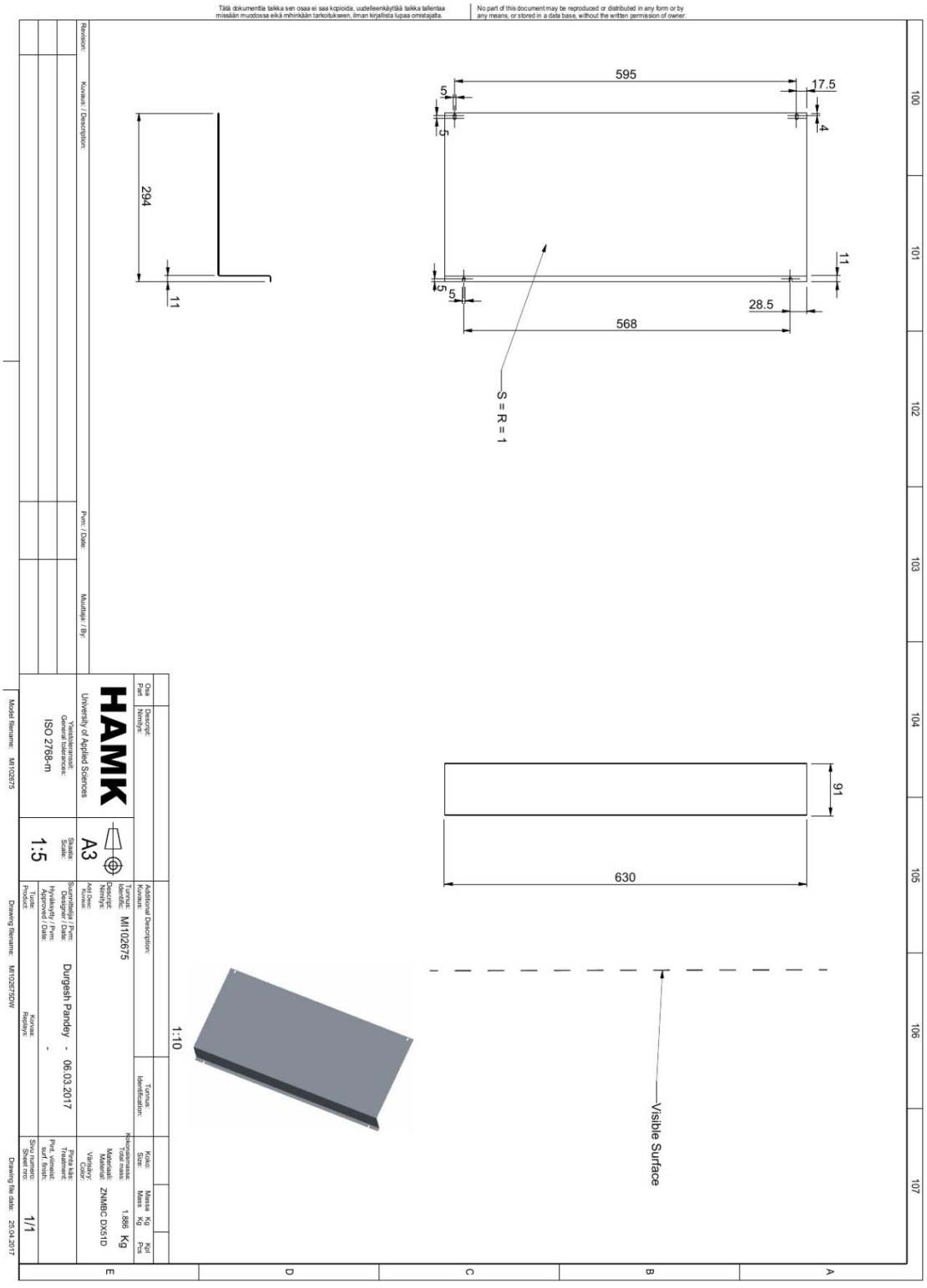
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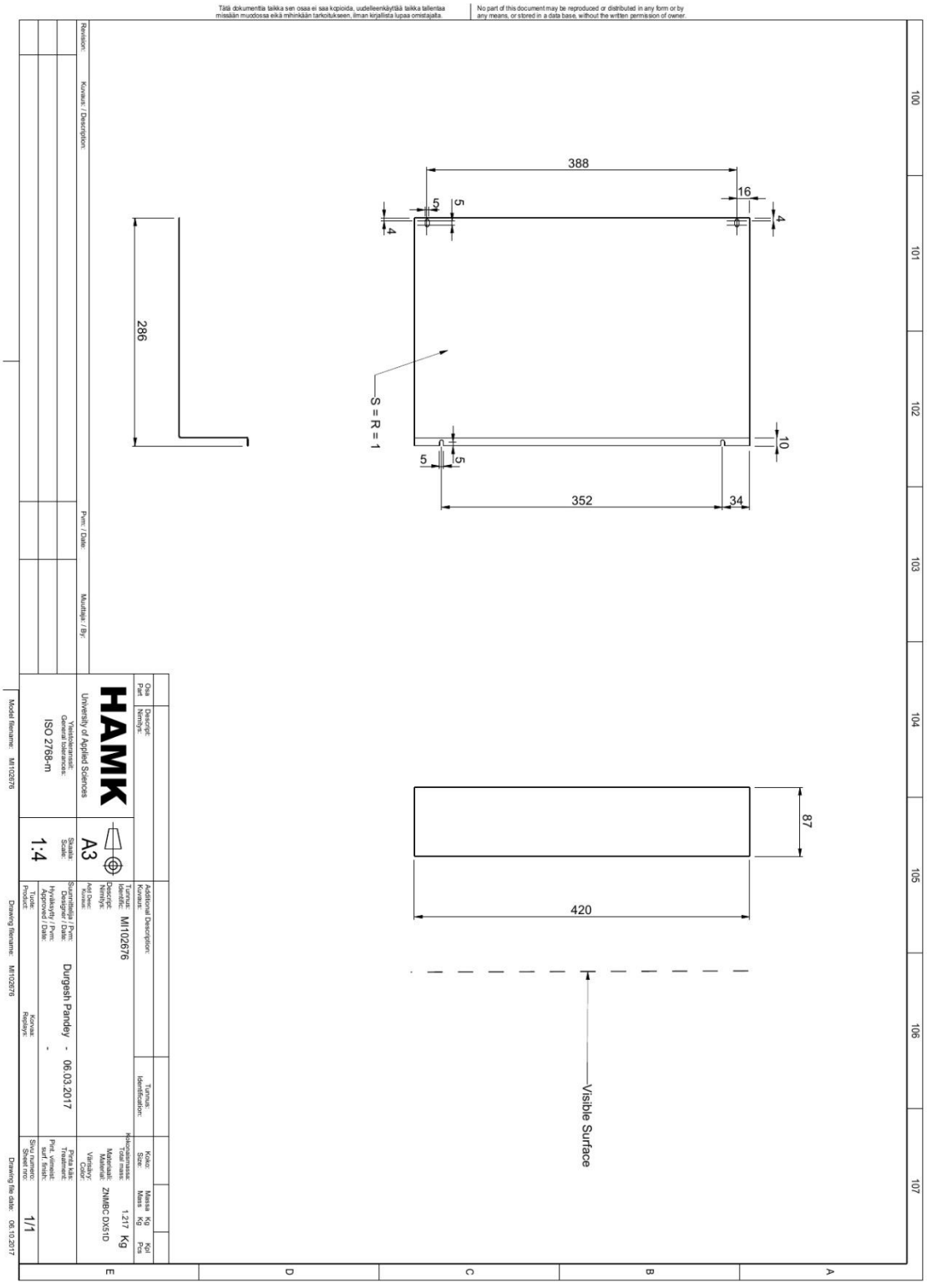
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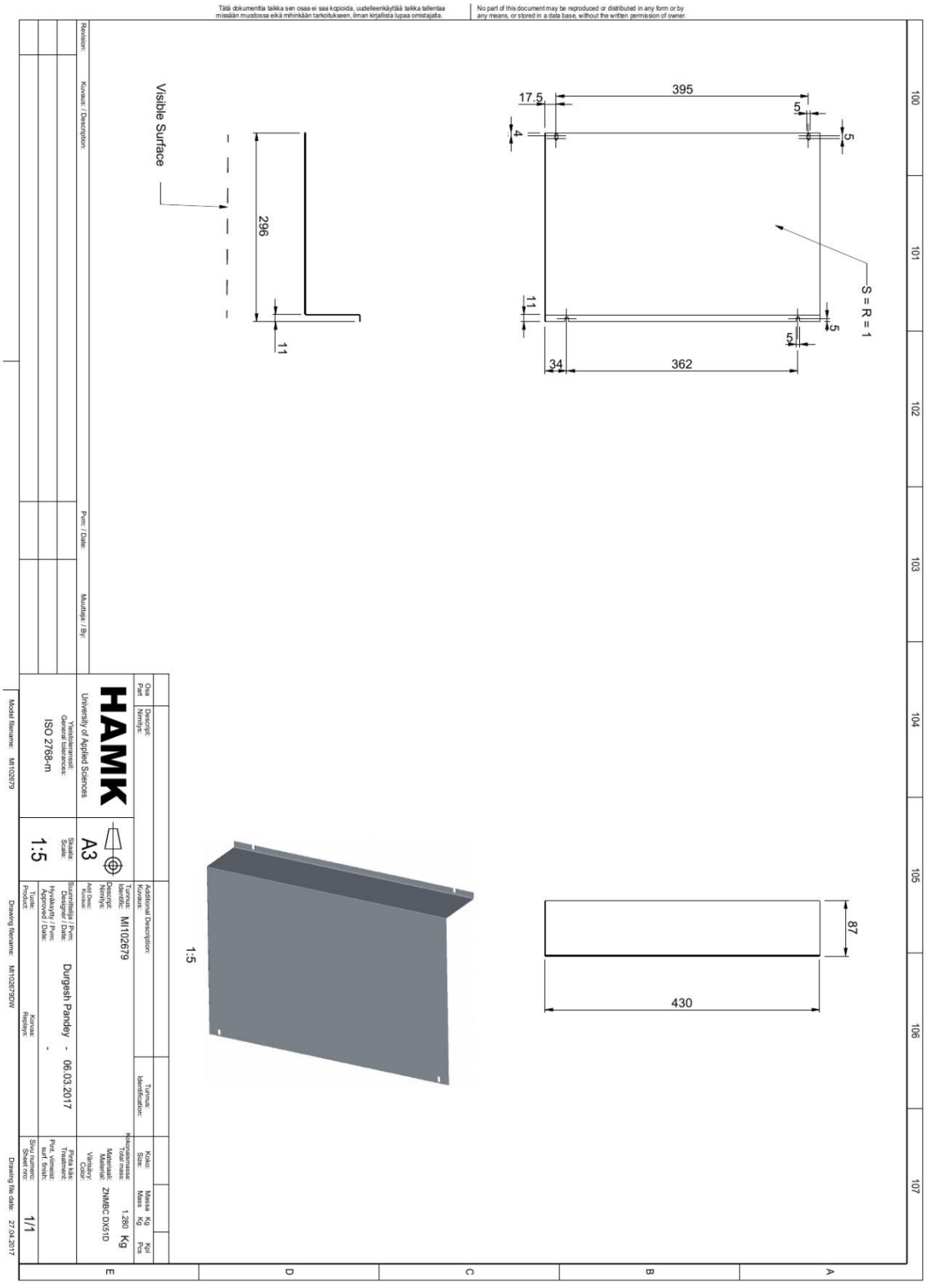
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University of Applied Sciences
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Durgesh Pandey - 06.03.2017
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Approved / Date:
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Korvaa:
Replaces:
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Product:
Kpl
Pcs
Massa Kg
Mass Kg
1.280 Kg
Koko:
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Kokonaismassa:
Total mass:
Materiaali:
Material:
ZNMBC DX51D
Värisävy:
Color:
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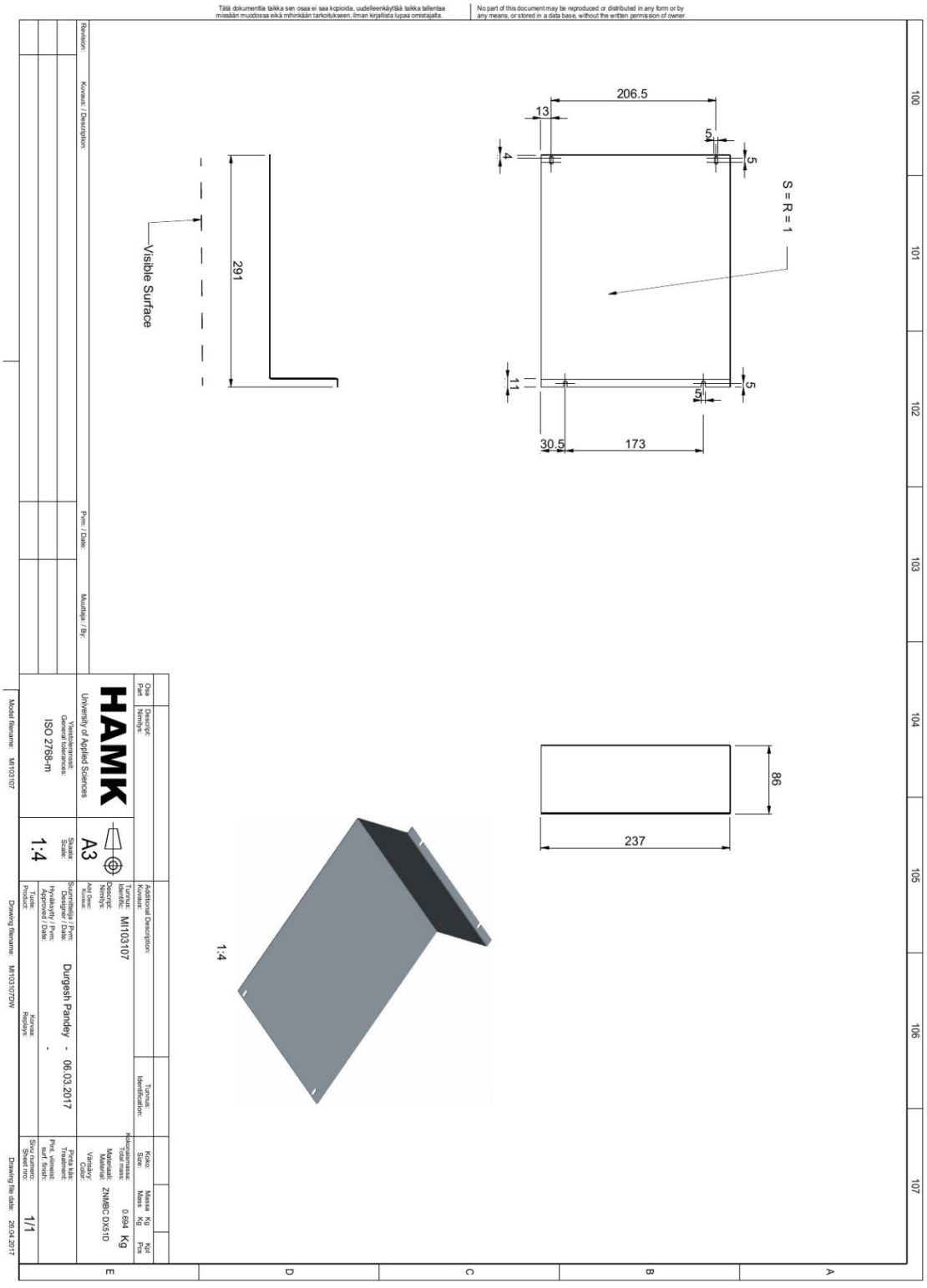
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1:4
HAMK
University of Applied Sciences
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ISO 2768-m
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Durgesh Pandey - 06.03.2017
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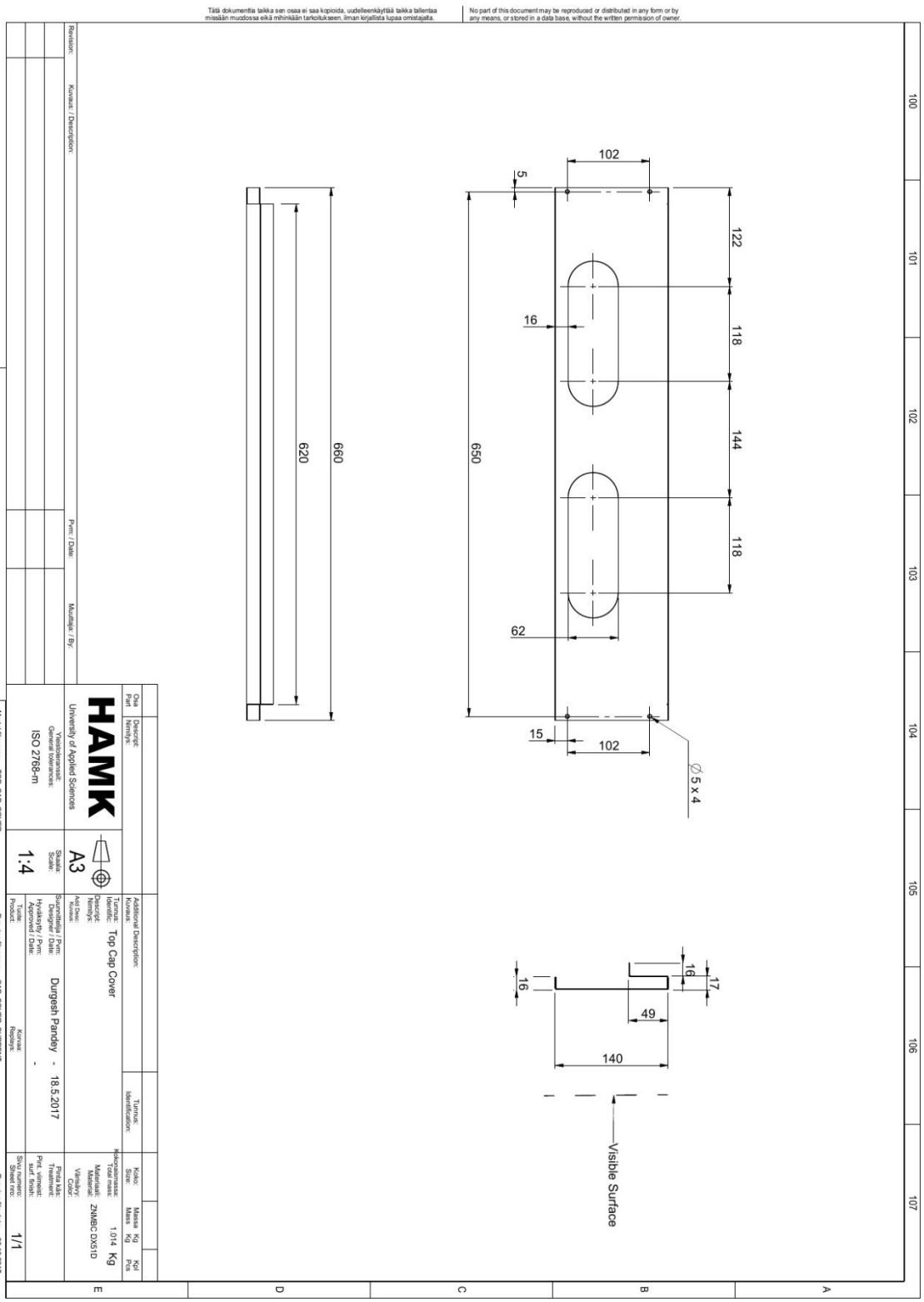
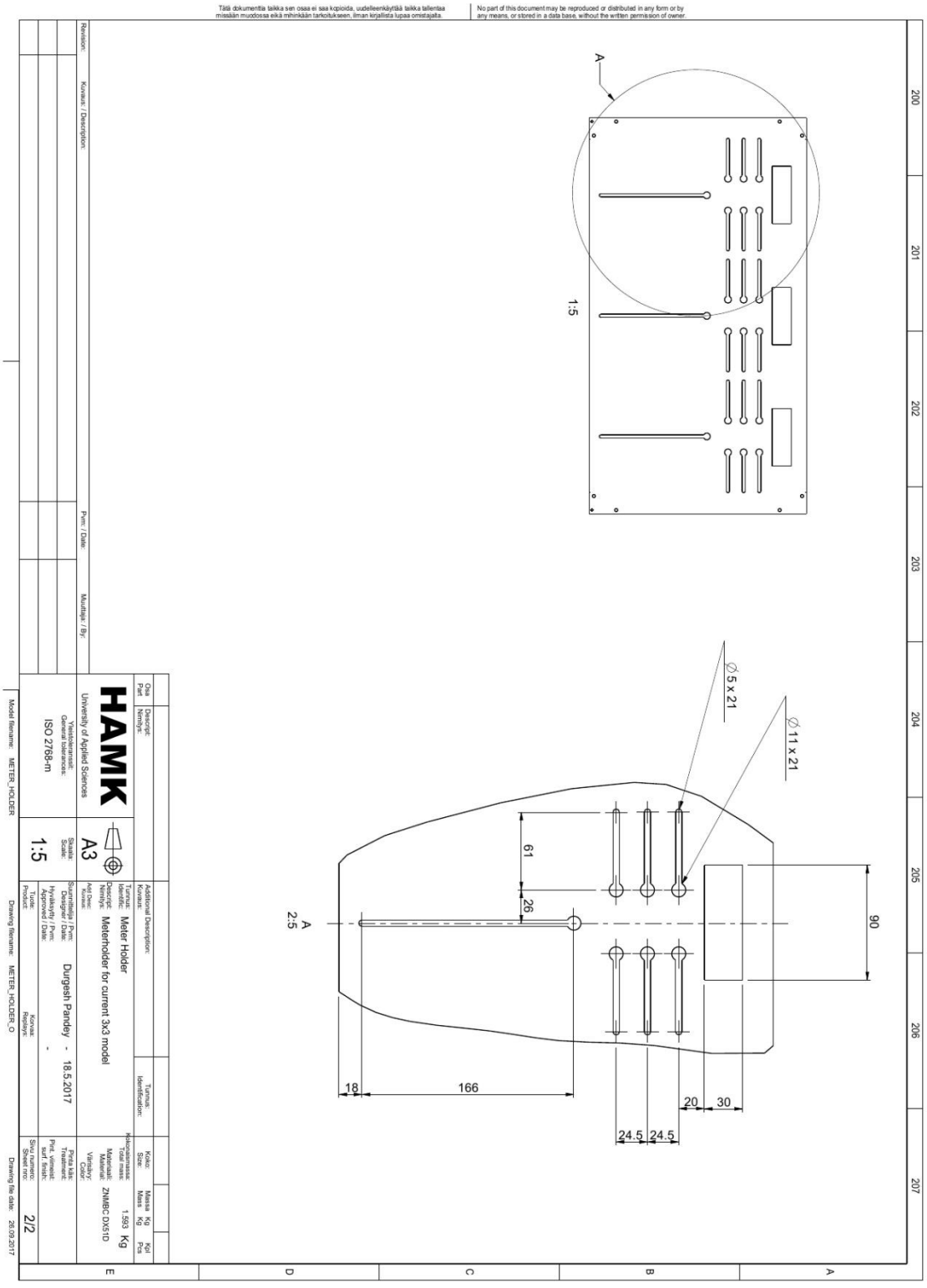
Appendix 2 Technical drawing for current panel frame parts

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A
1:5
Ø5 x 21
Ø11 x 21
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90
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2:5
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24.5
24.5
HAMK
University of Applied Sciences
A3
1:5
ISO 2768-m
Meterholder for current 3x3 model
Meter Holder
Durgesh Pandey - 18.5.2017
ZNMBC DX51D
1.593 Kg
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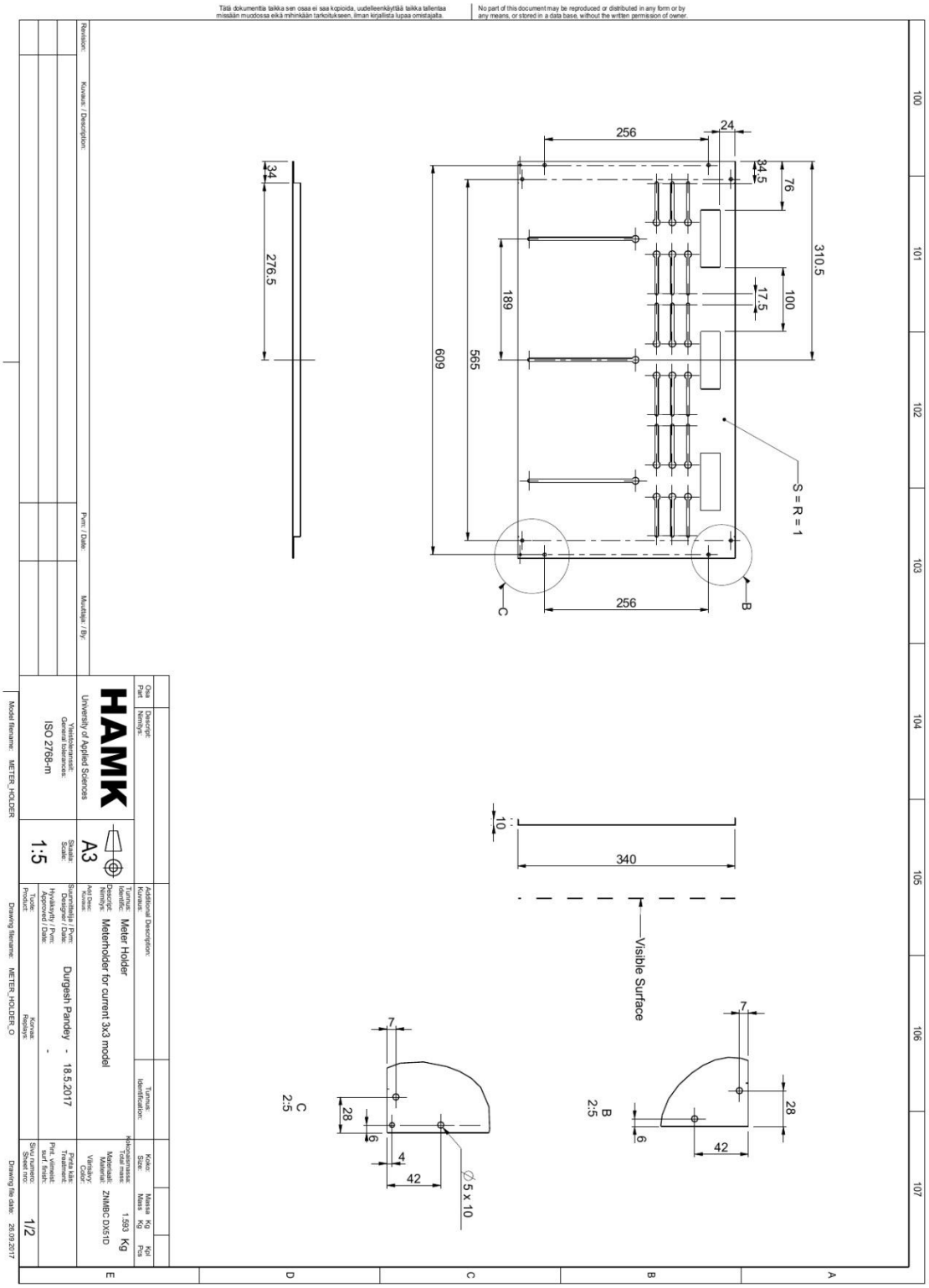
26.09.2017
METER_HOLDER
METER_HOLDER_O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University of Applied Sciences
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Additional Description: Kuvaus:
Tunnus: Identific: Meter Holder
Tunnus: Identification:
Description: Nimitys: Meterholder for current 3x3 model
Asti Desc: Kuvaus:
Suunnittelija / Pvm: Designer / Date: Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm: Approved / Date: -
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Tuote: Product:
Kpl Pcs
Koko: Size:
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Kokonaismassa: Total mass: 1.593 Kg
Materiaali: Material: ZNMBC DX51D
Värisävy: Color:
Pinta käs: Treatment:
Pinta laatu: Surf. finish:
Sivu numero: Sheet no: 1/2
Drawing file date: 26.09.2017
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Drawing filename: METER_HOLDER_O
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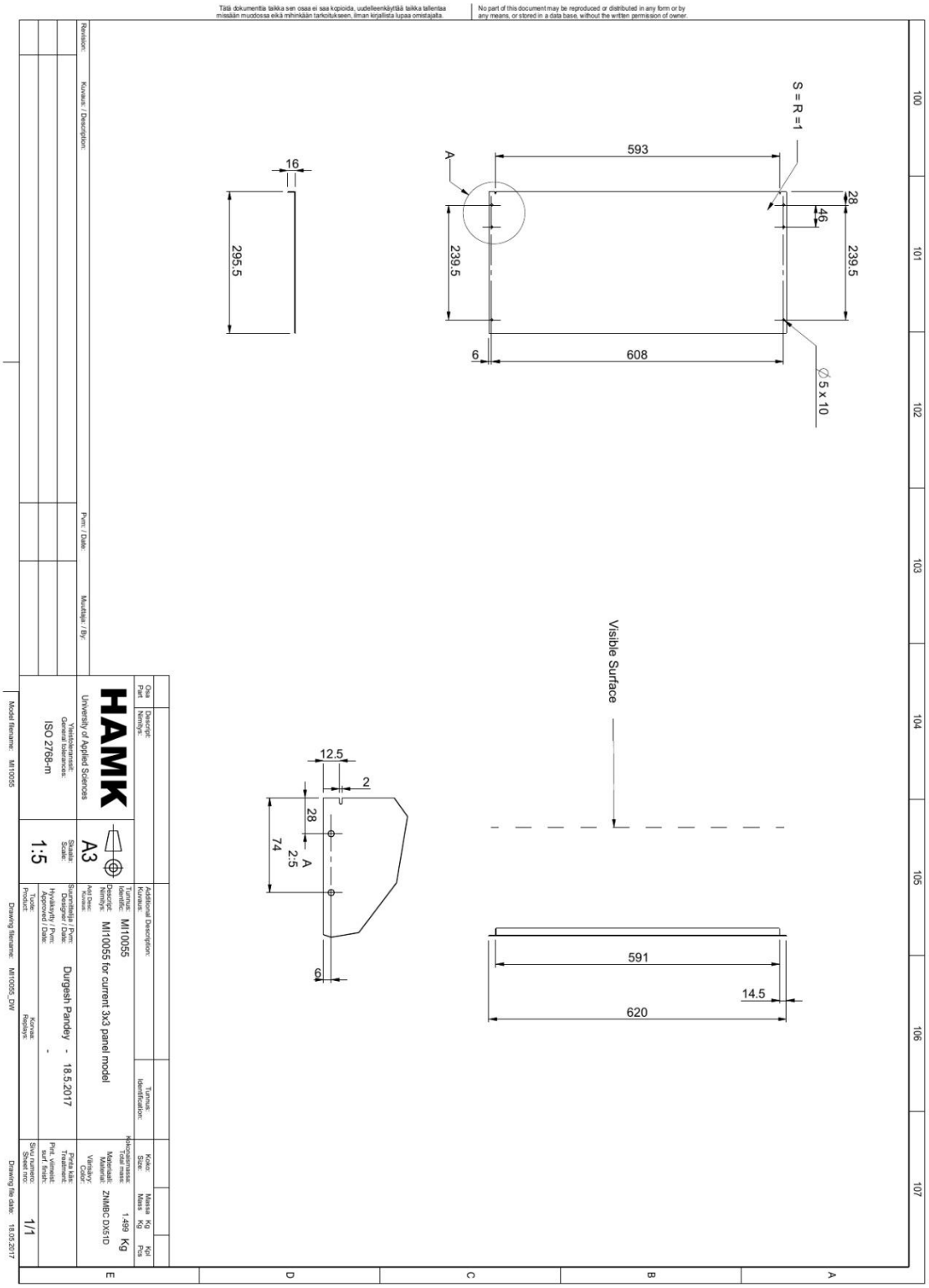
256
10
340
Visible Surface
7
28
6
42
B
2:5
7
28
6
4
42
∅ 5 x 10
C
2:5
100
101
102
103
104
105
106
107
A
B
C
D
E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missään muodossa eikä mihinkään tarkoitukseen, ilman kirjallista lupaa omistajalta.
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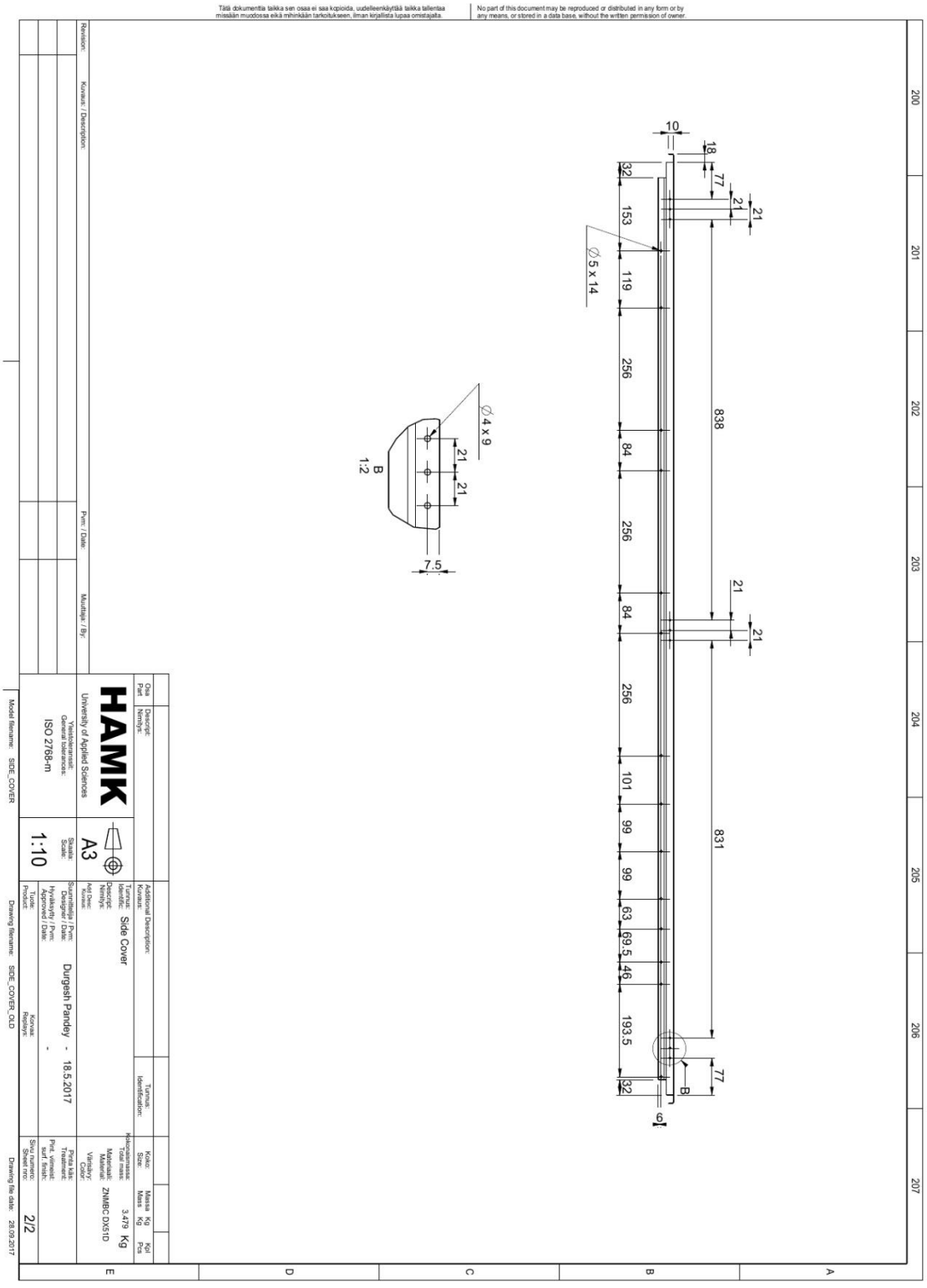
S = R =1
593
28
46
239.5
239.5
A
16
295.5
6
608
∅ 5 x 10
Visible Surface
12.5
2
28
74
2:5
A
6
591
14.5
620
HAMK
University of Applied Sciences
A3
1:5
ISO 2768-m
MI10055
MI10055 for current 3x3 panel model
Durgesh Pandey - 18.5.2017
ZNMBCDX51D
1.499 Kg
1/1
18.05.2017
MI10055
MI10055_DW
Revision:
Kuvaus / Description:
Pvm. / Date:
Muuttaja / By:
Model filename:
Drawing filename:
Drawing file date: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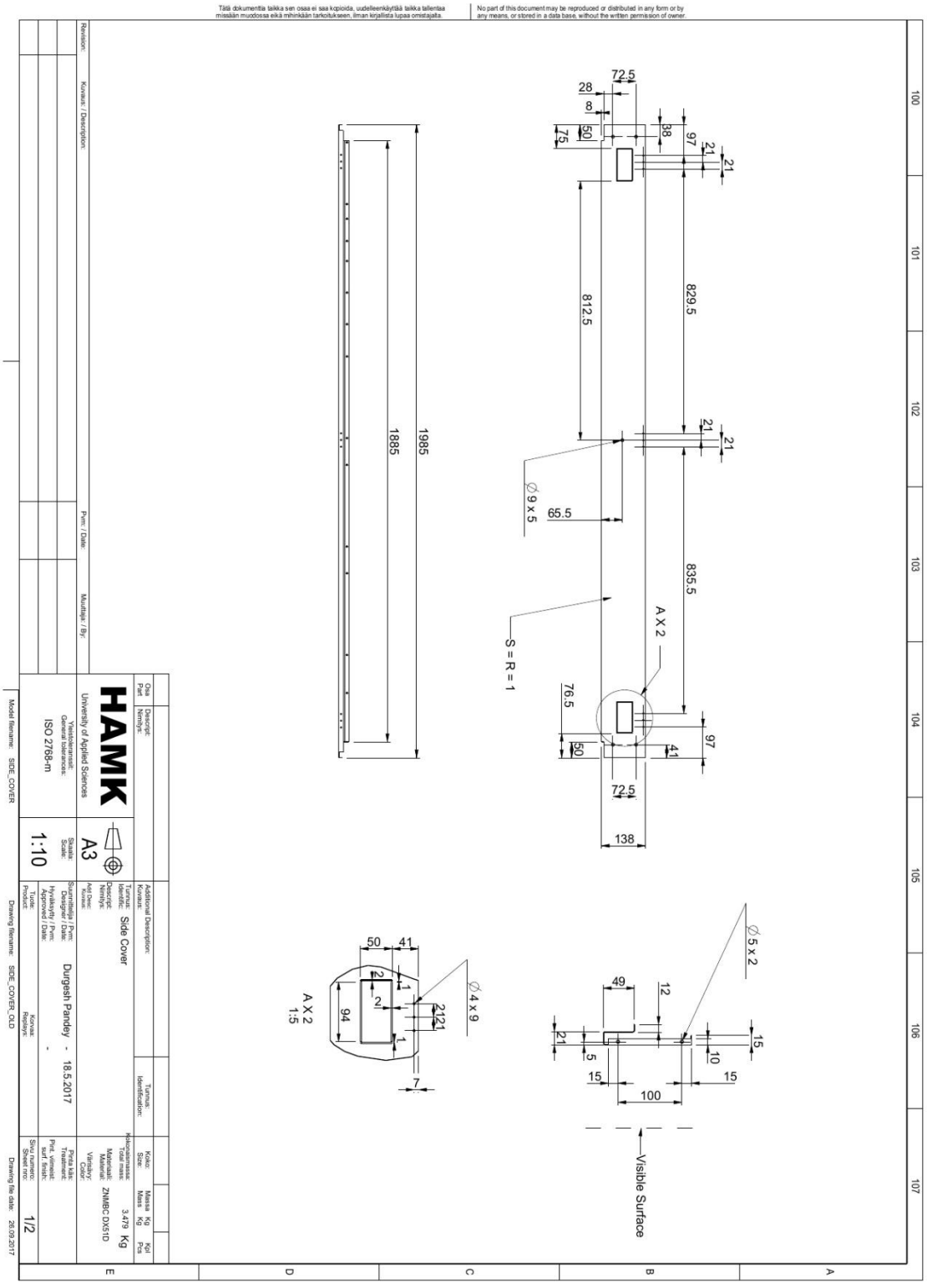
Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
HAMK
University of Applied Sciences
Yleistoleranssit: General tolerances:
ISO 2768-m
Mittakaava: Scale:
1:10
A3
Suunnittelija / Pvm: Designer / Date:
Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm: Approved / Date:
-
Korvaa: Replaces:
Tuote: Product:
Drawing filename: SIDE_COVER_OLD
Model filename: SIDE_COVER
Side Cover
Kokonaismassa: Total mass:
3.479 Kg
Materiaali: Material:
ZNMBC DX51D
Sivu numero: Sheet no:
2/2
Drawing file date: 28.09.2017
10
18
77
21
32
153
119
256
84
838
831
101
99
63
69.5
46
193.5
Ø5 x 14
Ø4 x 9
7.5
B
1:2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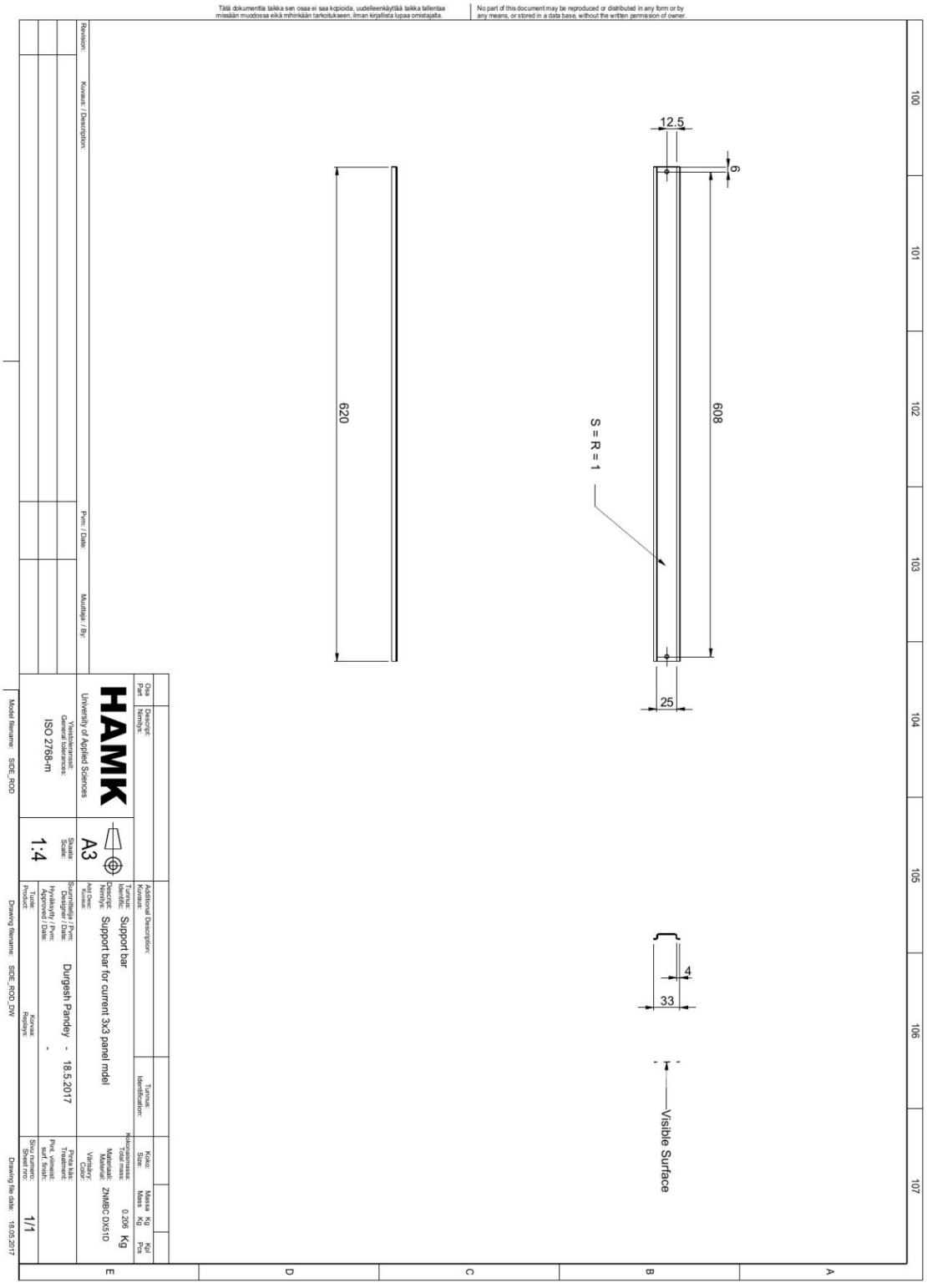
Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
HAMK
University of Applied Sciences
Yliopistonmerkit:
General tolerances:
ISO 2768-m
Osa Part
Description: Nimitys:
Mittakaava: Scale:
A3
1:10
Additional Description: Kuvaus:
Tunnus: Identific:
Side Cover
Suunnittelija / Pvm: Designer / Date:
Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm: Approved / Date:
-
Tuote: Product:
Korvaa: Replaces:
Tunnus: Identification:
Koko: Size:
Kpl Pcs
Massa Kg Mass Kg
Kokonaismassa: Total mass:
3.479 Kg
Materiaali: Material:
ZNMBC DX51D
Väri/pinty: Color:
Pinta käs: Treatment:
Pinn. laatu: Surf. finish:
Sivu numero: Sheet no:
1/2
Model filename: SIDE_COVER
Drawing filename: SIDE_COVER_OLD
Drawing file date: 26.09.2017
72.5
28
8
75
50
38
97
21
21
829.5
812.5
21
21
Ø 9 x 5
65.5
835.5
A X 2
S = R = 1
76.5
50
41
97
72.5
138
1985
1885
50
41
2
1
2
94
1
A X 2
1.5
Ø 4 x 9
21
21
7
Ø 5 x 2
49
12
21
5
15
10
15
100
Visible Surface
100
101
102
103
104
105
106
107
A
B
C
D
E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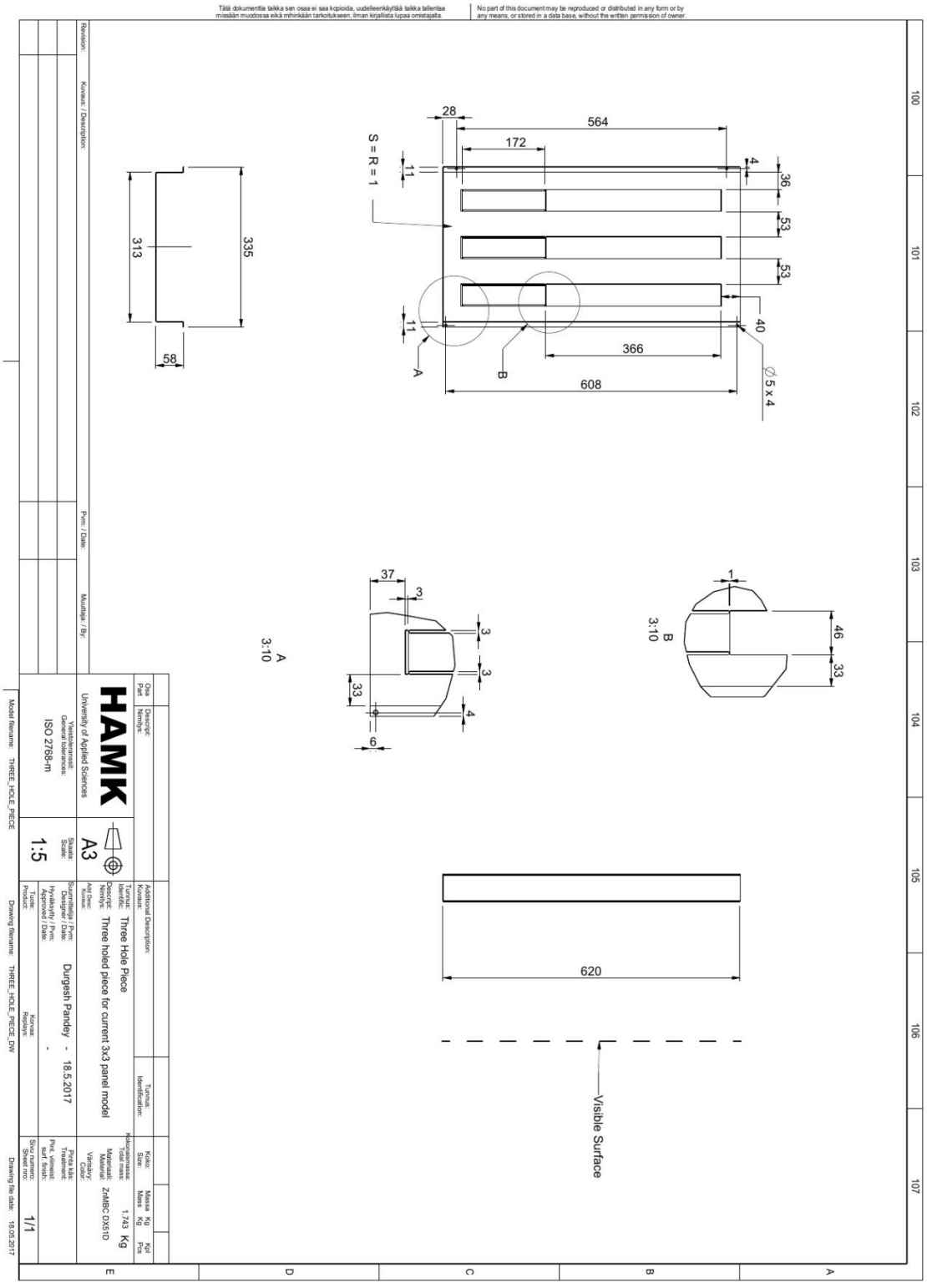
12.5
6
608
S = R = 1
620
25
4
33
Visible Surface
Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
HAMK
University of Applied Sciences
Yleistoleranssit:
General tolerances:
ISO 2768-m
Osa
Part
Description:
Nimitys:
Additional Description:
Kuvaus:
Tunnus:
Identific:
Support bar
Support bar for current 3x3 panel mdel
Lisät. Dwg:
Kuvaus:
Mittakaava:
Scale:
1:4
A3
Suunnittelija / Pvm:
Designer / Date:
Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm:
Approved / Date:
-
Tuote:
Product
Korvaa:
Replaces
Kpl
Pcs
Kokonaismassa:
Total mass:
0.206 Kg
Materiaali:
Material:
ZNMBC DX51D
Väri/pinty:
Color:
Koko:
Size:
Massa Kg
Mass Kg
Pinta käs:
Surf. finish:
Pinta käs:
Treatment:
Sivu numero:
Sheet no:
1/1
Model filename: SIDE_ROD
Drawing filename: SIDE_ROD_DW
Drawing file date: 18.05.2017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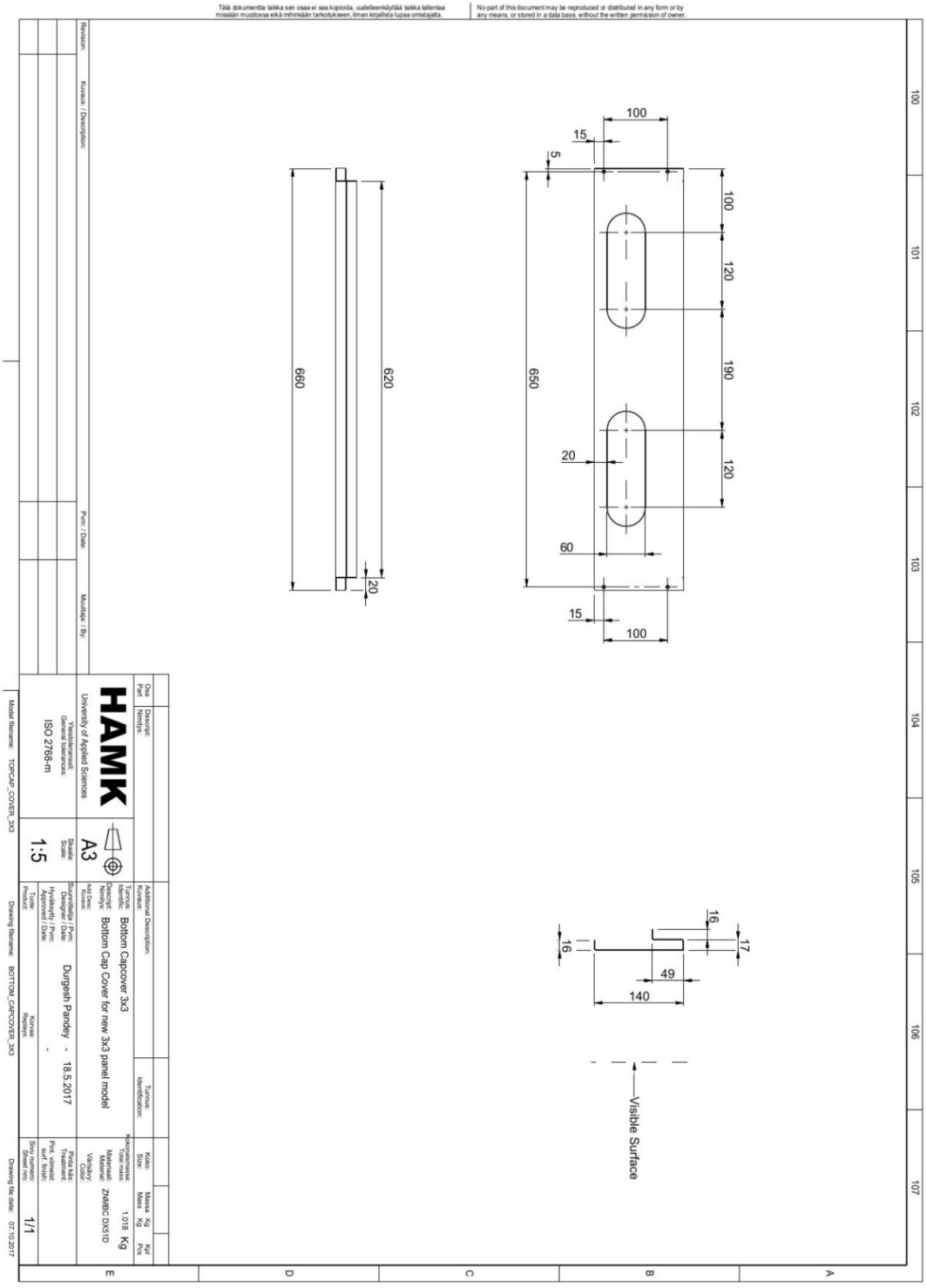
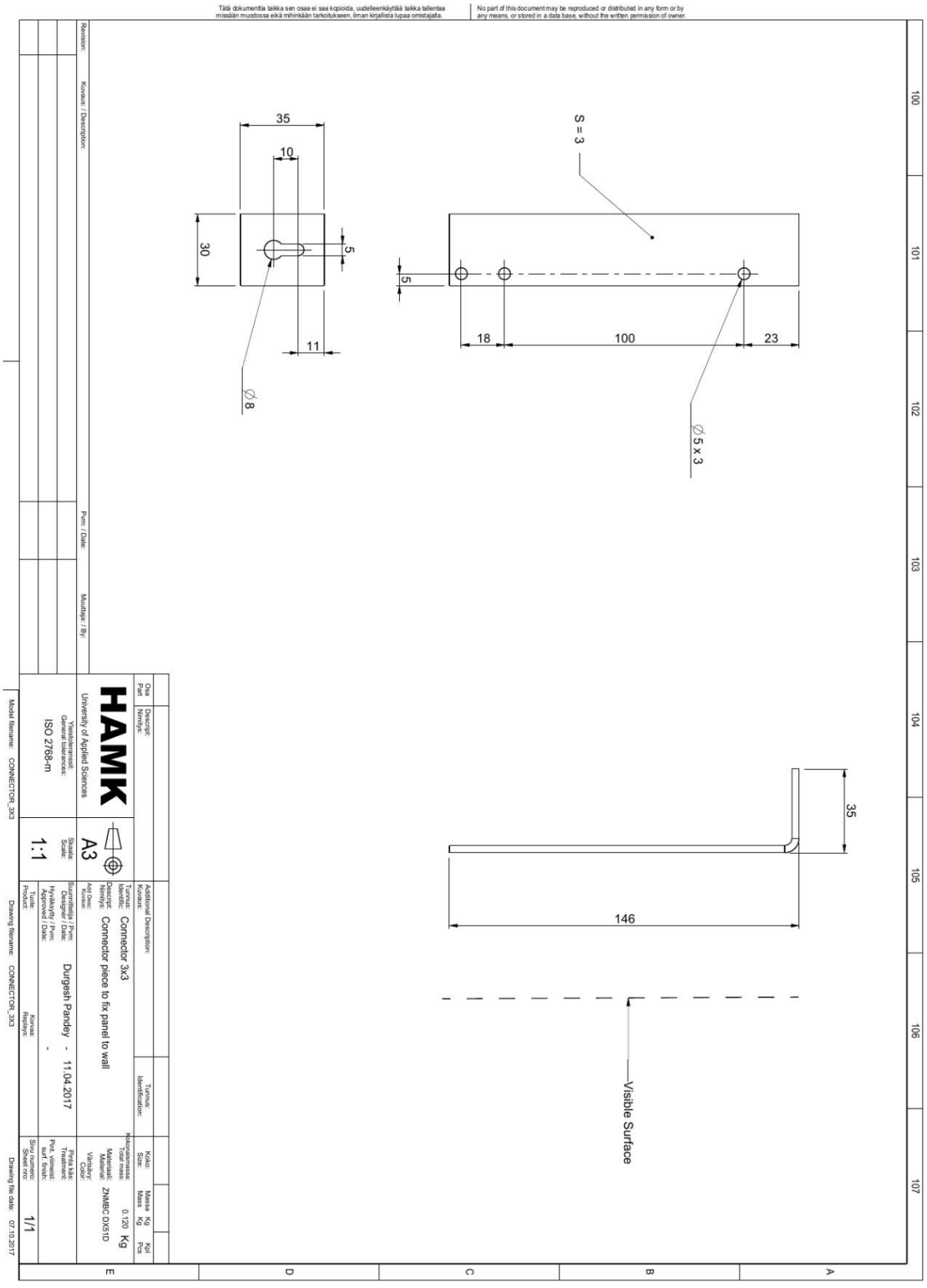
28
564
172
4
36
53
53
S = R = 1
11
11
40
366
608
A
B
Ø 5 x 4
335
313
58
37
3
3
3
33
4
6
A
3:10
1
46
33
B
3:10
620
Visible Surface
HAMK
University of Applied Sciences
Three Hole Piece
Three holed piece for current 3x3 panel model
Durgesh Pandey - 18.5.2017
ISO 2768-m
A3
1:5
ZnMBC DX51D
1.743 Kg
THREE_HOLE_PIECE
THREE_HOLE_PIECE_DW
18.05.2017
1/1

Appendix 3 Technical drawing for new 3x3 panel model parts

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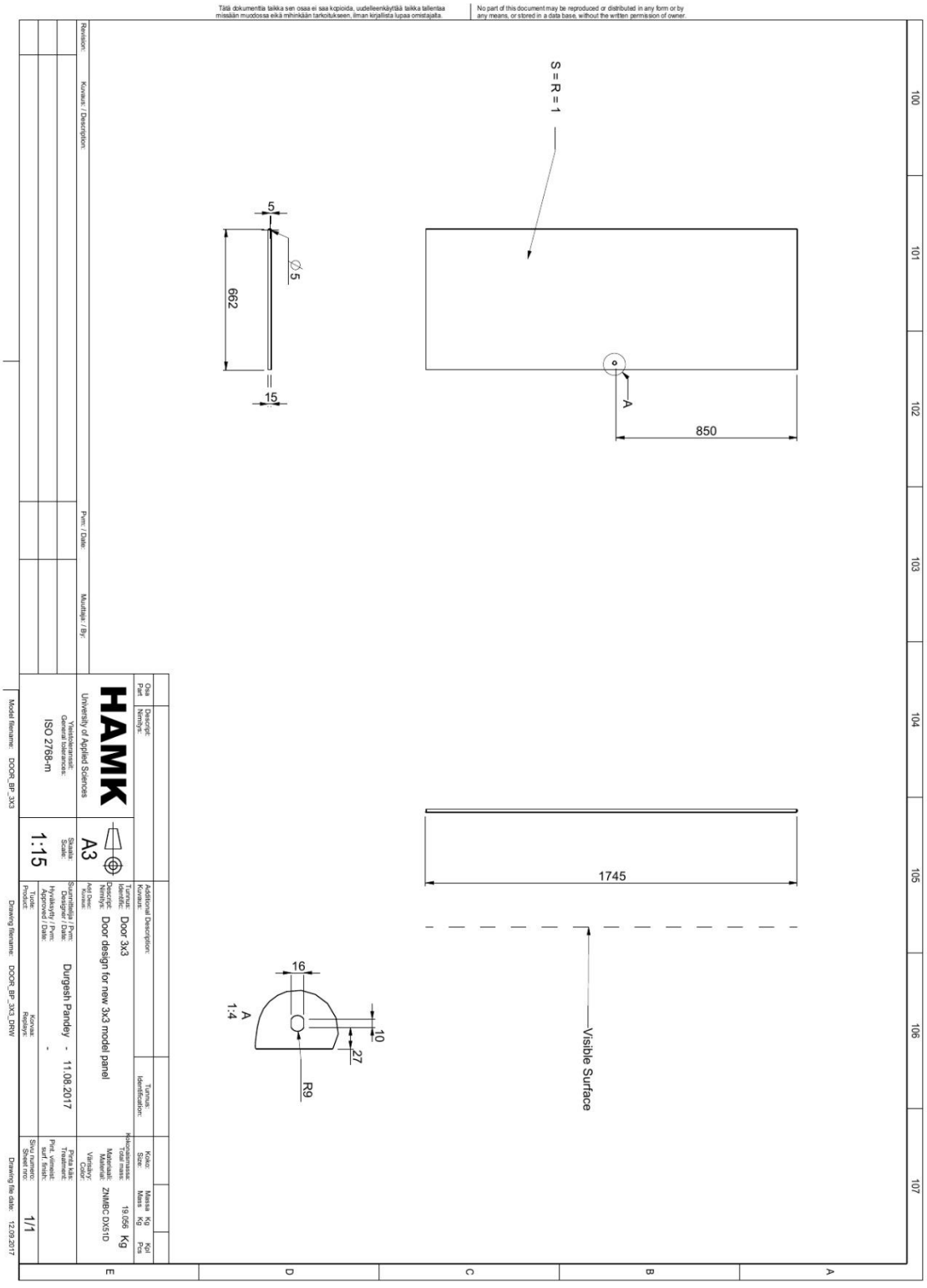
Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
35
10
30
5
11
Ø 8
S = 3
5
18
100
23
Ø 5 x 3
35
146
Visible Surface
Oma Part
Description: Nimitys:
HAMK
University of Applied Sciences
Yleistoleranssit: General tolerances: ISO 2768-m
Skaala: Scale: 1:1
A3
Additional Description: Kuvaus:
Tunnus: Identific:
Connector 3x3
Description: Nimitys:
Connector piece to fix panel to wall
Tunnus: Identification:
Kpl Pcs
Kokoonpanomass: Total mass:
Massa: Mass: Kg 0.120 Kg
Koko: Size:
Materiaali: Material: ZNMBC DX51D
Väri/pinty: Color:
Pinta käs: Treatment:
Pinn. laatu: Surf. finish:
Sivu numero: Sheet no: 1/1
Suunnittelija / Pvm: Designer / Date: Durgesh Pandey - 11.04.2017
Hyväksyjä / Pvm: Approved / Date: -
Korvaa: Replaces
Tuote: Product
Model filename: CONNECTOR_3X3
Drawing filename: CONNECTOR_3X3
Drawing file date: 07.10.2017
100
101
102
103
104
105
106
107
A
B
C
D
E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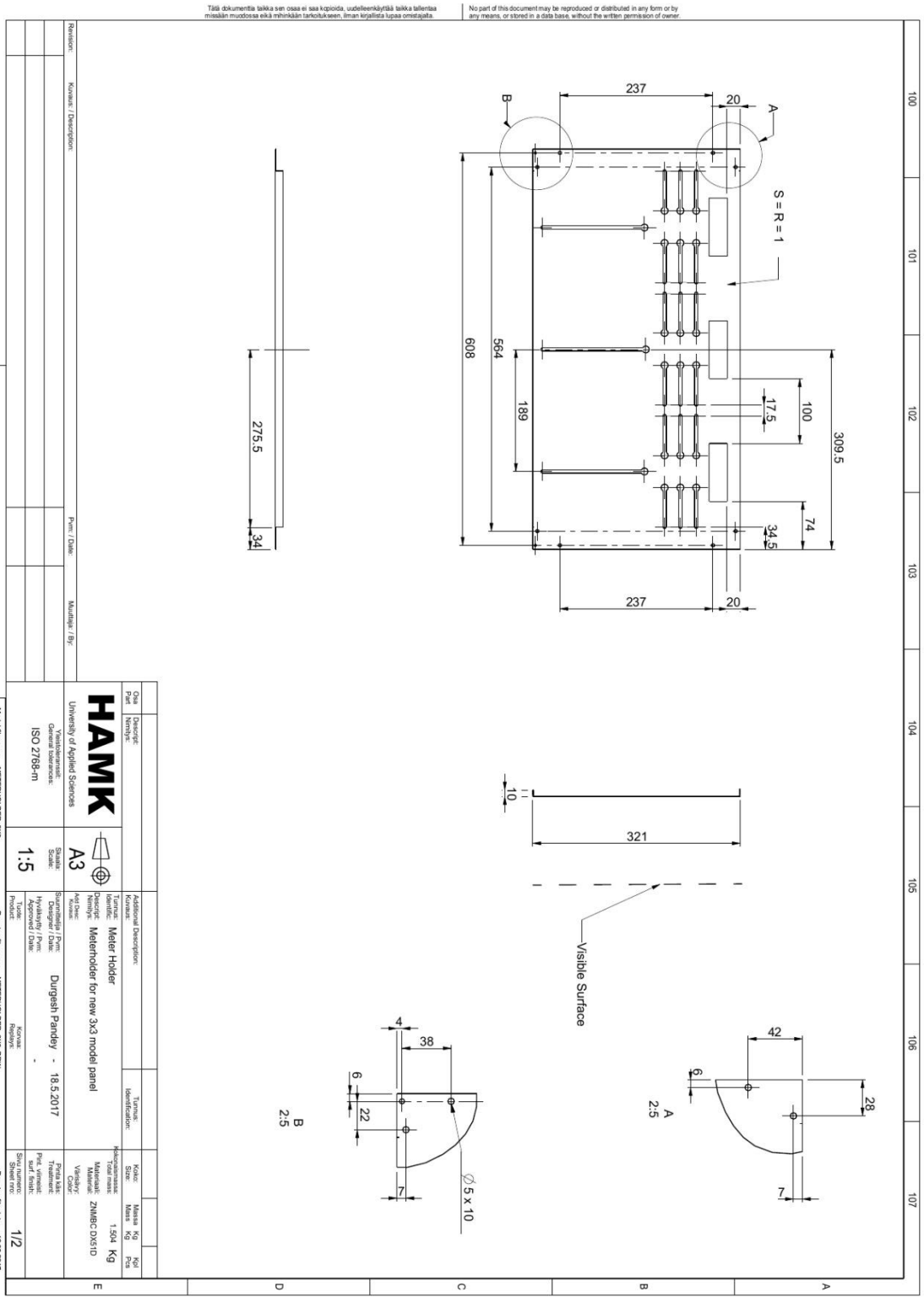
S = R = 1
5
Ø 5
662
15
A
850
1745
Visible Surface
16
A
1:4
10
27
R9
Revision:
Kuvaus / Description:
Pvm. / Date:
Muuttaja / By:
HAMK
University of Applied Sciences
Yleistoleranssit:
General tolerances:
ISO 2768-m
Osa
Part
Description:
Nimitys:
Mittakaava:
Scale:
1:15
A3
Additional Description:
Kuvaus:
Tunnus:
Identific:
Door 3x3
Nimitys:
Door design for new 3x3 model panel
Tunnus:
Identification:
Suunnittelija / Pvm:
Designer / Date:
Durgesh Pandey - 11.08.2017
Hyväksyjä / Pvm:
Approved / Date:
-
Korvaa:
Replaces:
Tuote:
Product:
Kpl
Pcs
Massa Kg
Mass Kg
Kokonaismassa:
Total mass:
19.056 Kg
Materiaali:
Material:
ZNMBCi DX51D
Koko:
Size:
Värisävy:
Color:
Pinta käs:
Treatment:
Pinta laatu:
Surf. finish:
Sivu numero:
Sheet no:
1/1
Model filename: DOOR_BP_3X3
Drawing filename: DOOR_BP_3X3_DRW
Drawing file date: 12.09.2017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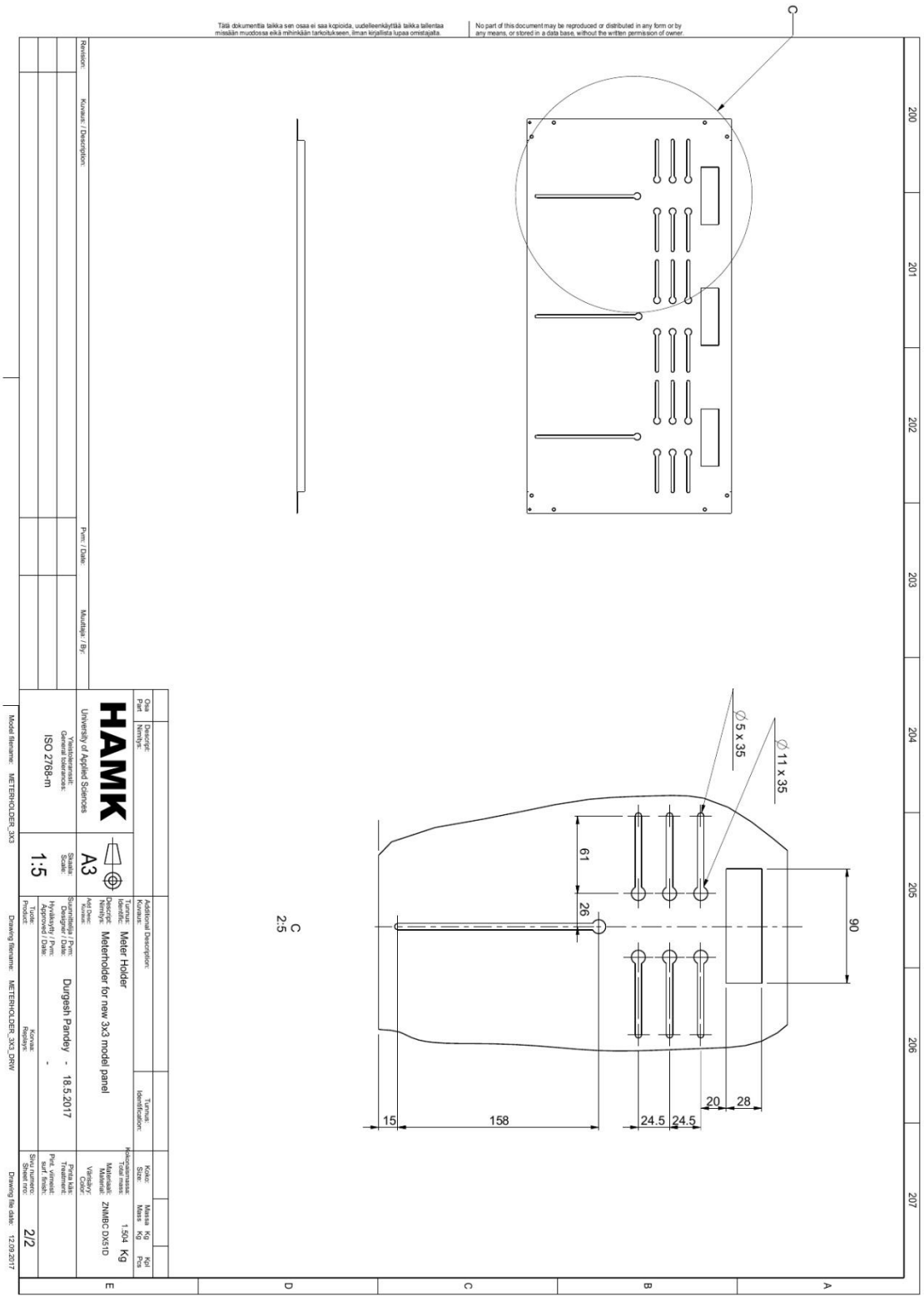
237
20
A
B
S = R = 1
608
564
189
17.5
100
309.5
74
34.5
237
20
275.5
34
10
321
Visible Surface
42
6
28
7
A
2:5
4
38
6
22
7
Ø 5 x 10
B
2:5
HAMK
University of Applied Sciences
Meter Holder
Meterholder for new 3x3 model panel
Durgesh Pandey - 18.5.2017
ISO 2768-m
A3
1:5
1.504 Kg
ZNMBC DX51D
1/2
Model filename: METERHOLDER_3X3
Drawing filename: METERHOLDER_3X3_DRW
Drawing file date: 12.09.2017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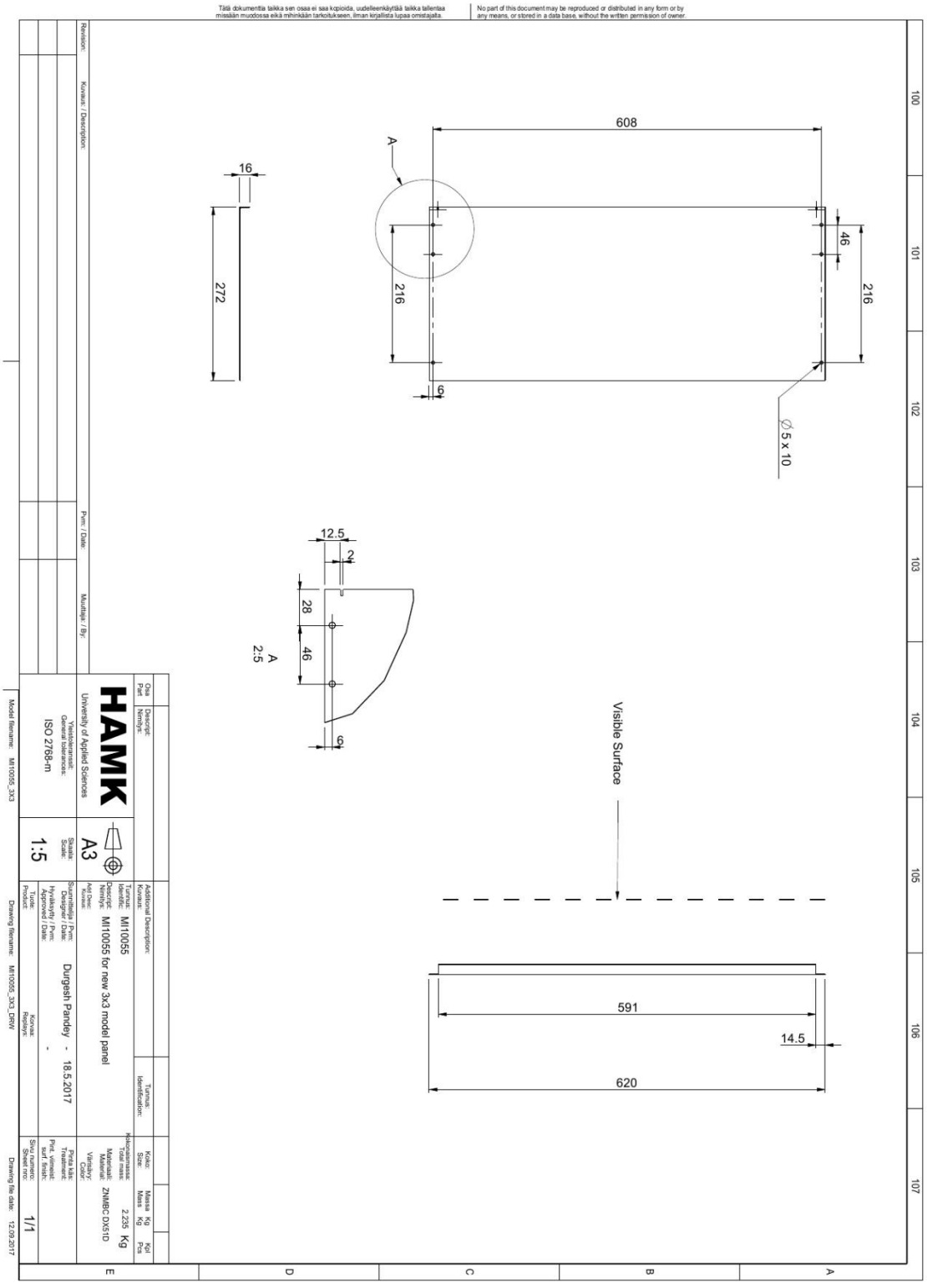
C
Ø 5 x 35
Ø 11 x 35
61
26
90
15
158
24.5
24.5
20
28
C
2:5
HAMK
University of Applied Sciences
Meterholder for new 3x3 model panel
Meter Holder
Durgesh Pandey - 18.5.2017
ISO 2768-m
A3
1:5
1.504 Kg
ZNMBC DX51D
2/2
Model filename: METERHOLDER_3X3
Drawing filename: METERHOLDER_3X3_DRW
Drawing file date: 12.09.2017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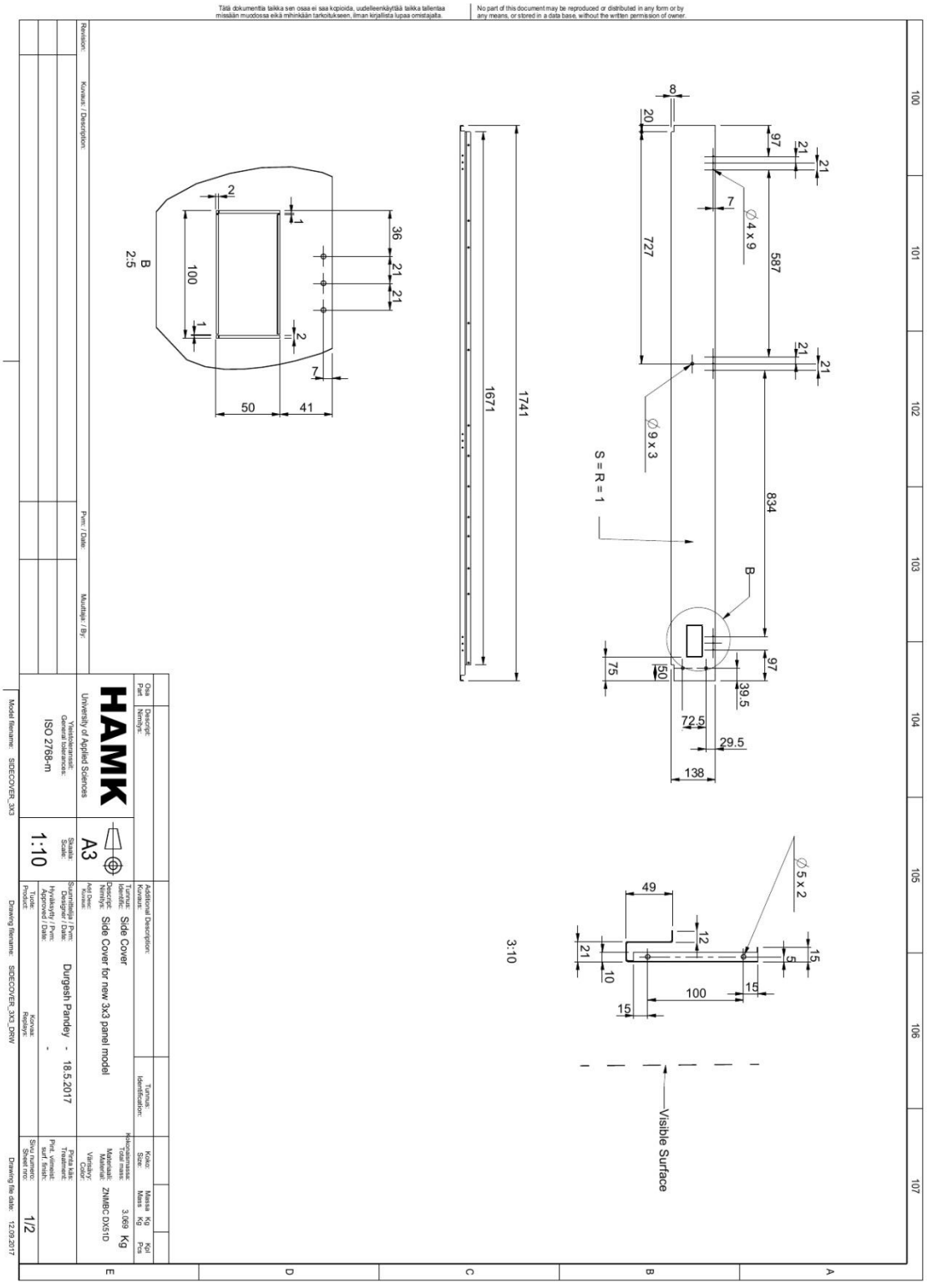
608
16
272
216
46
216
6
Ø 5 x 10
12.5
2
28
46
6
A
2.5
Visible Surface
591
14.5
620
HAMK
University of Applied Sciences
A3
1:5
ISO 2768-m
MI10055
MI10055 for new 3x3 model panel
Durgesh Pandey - 18.5.2017
2.235 Kg
ZNMBC DX51D
1/1
Model filename: MI10055_3X3
Drawing filename: MI10055_3X3_DRW
Drawing file date: 12.09.2017


Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa
missään muodossa eikä mihinkään tarkoitukseen, ilman kirjallista lupaa omistajalta.
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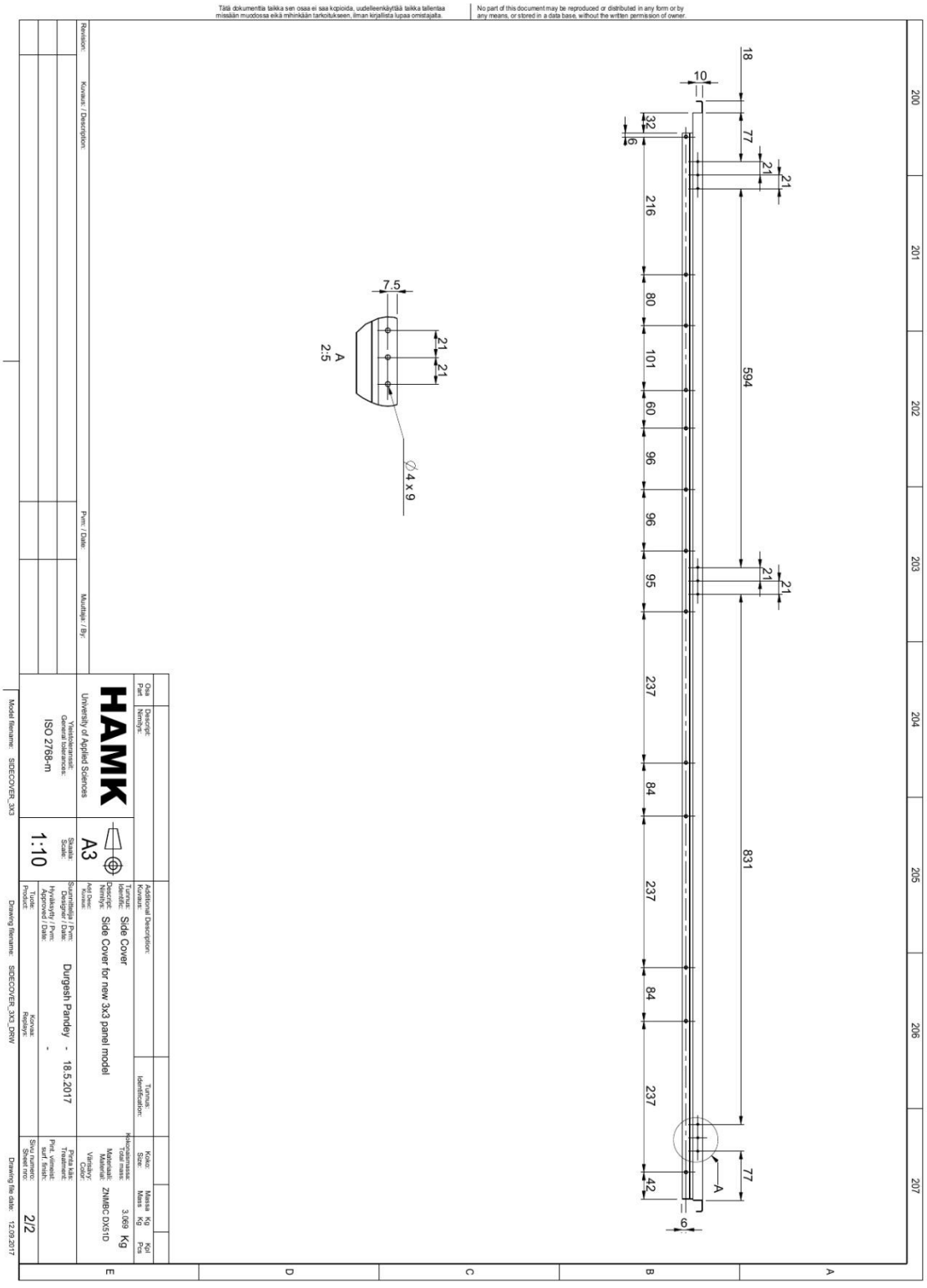
Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
HAMK
University of Applied Sciences
Yleistoleranssit:
General tolerances:
ISO 2768-m
Osa
Part
Description:
Nimitys:
Additional Description:
Kuvaus:
Tuotenr.
Identification:
Tuotnr.
Identific:
Side Cover
Nimitys:
Description:
Side Cover for new 3x3 panel model
Asti Desc:
Kuvaus:
Mitta:
Scale:
A3
1:10
Suunnittelija / Pvm:
Designer / Date:
Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm:
Approved / Date:
-
Korvaa:
Replaces:
Tuote:
Product:
Kriitt:
Size:
Massa Kg
Mass Kg
Kpl
Pcs
Kokonaismassa:
Total mass:
3,069 Kg
Materiaali:
Material:
ZNMBC DX51D
Värisävy:
Color:
Pinta käs:
Treatment:
Pinn. karkeus:
Surf. finish:
Sivu numero:
Sheet no:
1/2
Model filename: SIDECOVER_3X3
Drawing filename: SIDECOVER_3X3_DRW
Drawing file date: 12.09.2017
S = R = 1
3:10
B
2:5
Visible Surface
Ø 4 x 9
Ø 9 x 3
Ø 5 x 2
1741
1671
727
587
834
138
100
50
41
72.5
29.5
39.5
97
75
49
12
15
10
21
20
8
7
36
2
1
A
B
C
D
E


Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa
missään muodossa eikä mihinkään tarkoitukseen, ilman kirjallista lupaa omistajalta.
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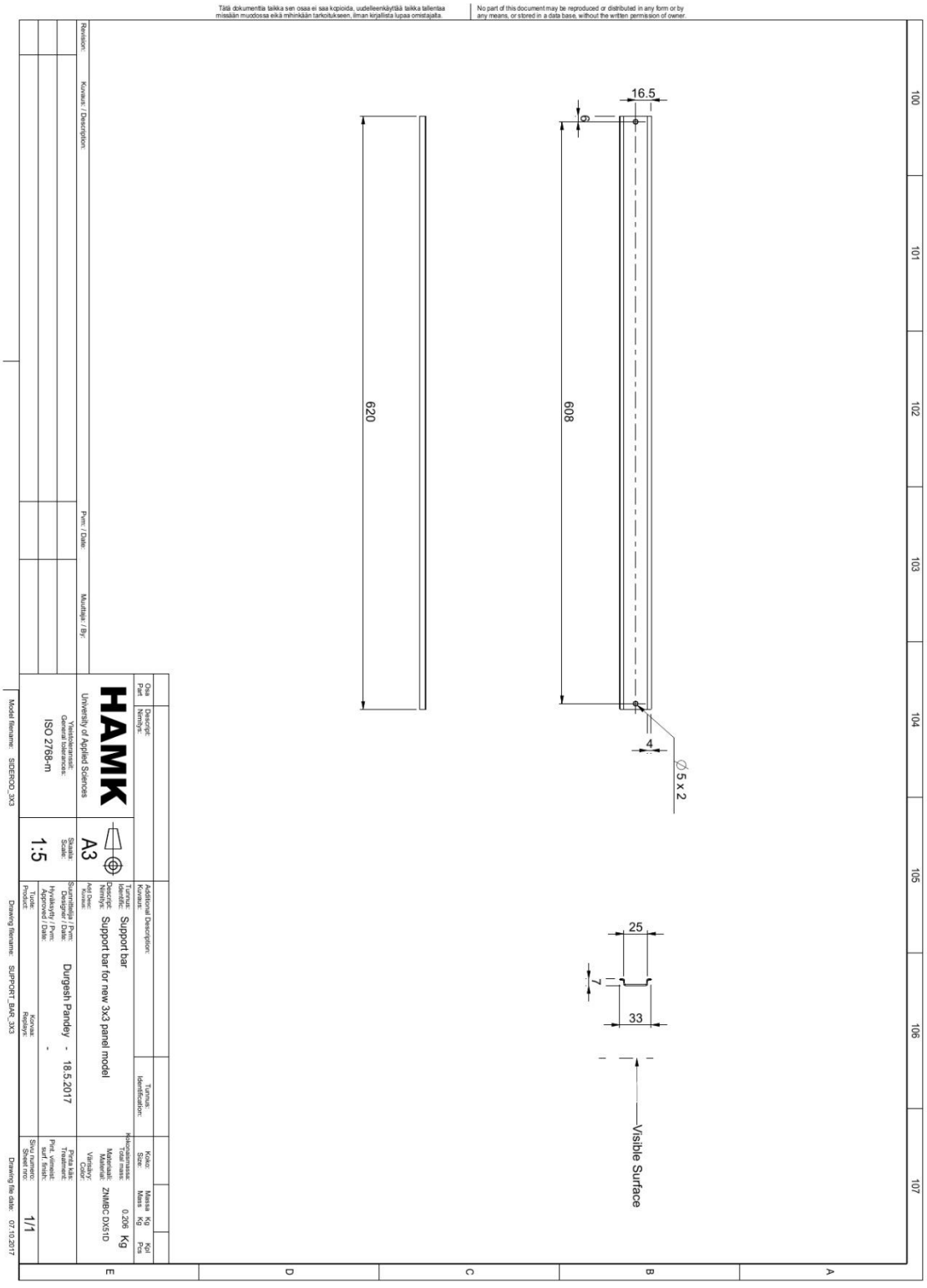
any means, or stored in a data base, without the written permission of owner.
18
10
32
6
77
21
21
216
80
101
60
96
96
95
237
84
237
84
237
594
831
21
21
77
42
A
6
7.5
21
21
A
2:5
Ø 4 x 9
HAMK
University of Applied Sciences
Side Cover
Side Cover for new 3x3 panel model
Durgesh Pandey - 18.5.2017
ISO 2768-m
A3
1:10
ZNMBC DX51D
3,069 Kg
2/2
SIDECOVER_3X3
SIDECOVER_3X3_DRW
12.09.2017


Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa
missään muodossa eikä mihinkään tarkoituksseen, ilman kirjallista lupaa omistajalta.
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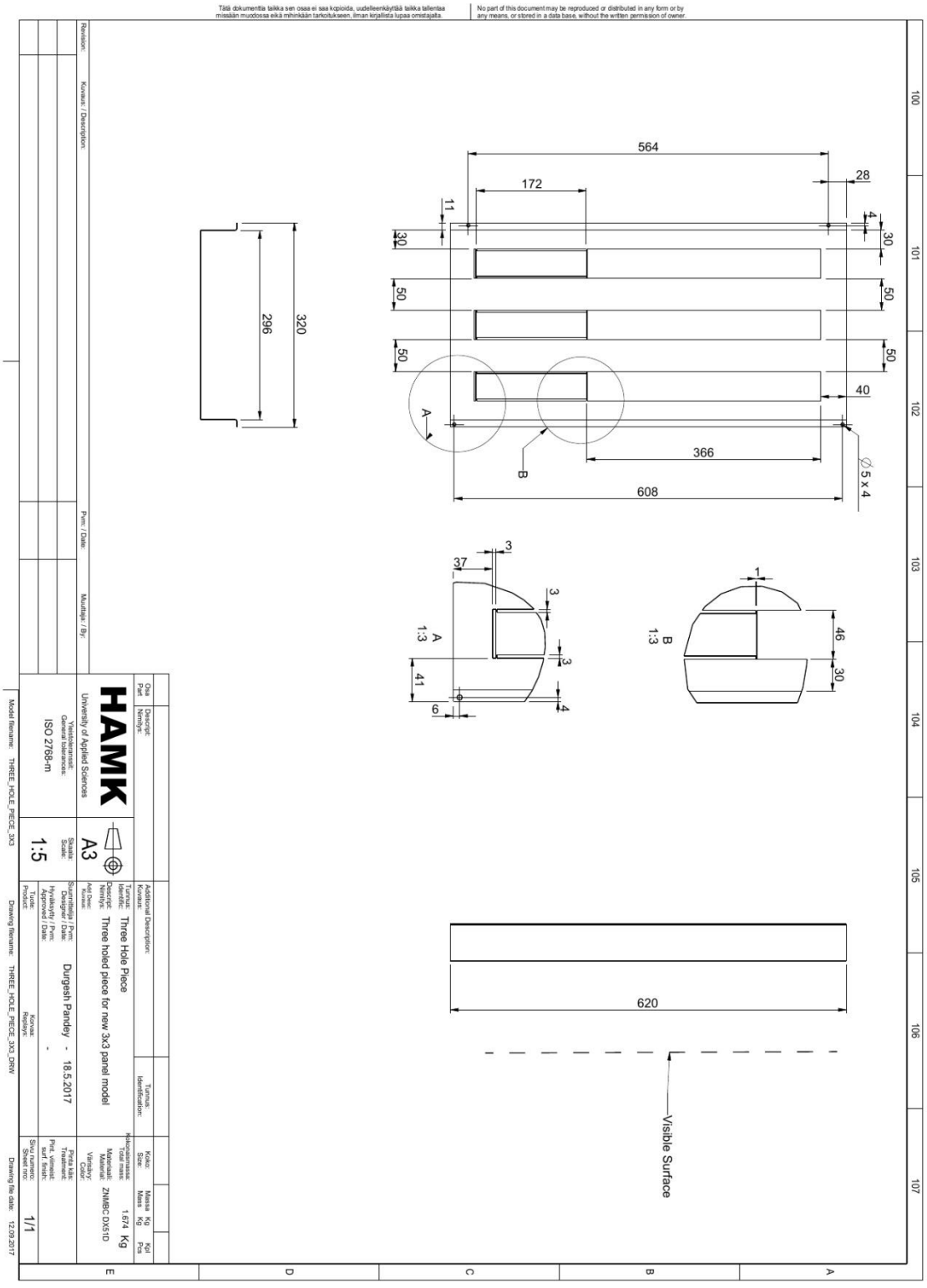
any means, or stored in a data base, without the written permission of owner.
16.5
6
620
608
4
Ø 5 x 2
25
7
33
Visible Surface
Revision:
Kuvaus / Description:
Pvm. / Date:
Muuttaja / By:
HAMK
University of Applied Sciences
Yleistoleranssit:
General tolerances:
ISO 2768-m
Mittakaava:
Scale:
A3
1:5
Osa
Part
Description
Nimitys:
Additional Description
Kuvaus:
Tunnus
Identification:
Tunnus:
Identific:
Support bar
Nimitys:
Support bar for new 3x3 panel model
Lisät. Osa:
Kuvaus:
Suunnittelija / Pvm:
Designer / Date:
Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm:
Approved / Date:
-
Korvaa:
Replaces:
Tuote:
Product:
Piirustus:
Drawing file name:
SUPPORT_BAR_3X3
Mallin tiedostonimi:
Model filename:
SIDEROD_3X3
Kpl
Pcs
Massa Kg
Mass Kg
0.206 Kg
Kokonaismassa:
Total mass:
Materiaali:
Material:
ZNMBC DX51D
Väri/pinty:
Color:
Koko:
Size:
Pinta käs:
Treatment:
Pinn. käsittely:
Surf. finish:
Sivu numero:
Sheet no:
1/1
Piirustus tiedostopäivä:
Drawing file date:
07.10.2017
A
B
C
D
E
100
101
102
103
104
105
106
107


564
172
28
11
4
30
50
50
50
40
366
608
Ø 5 x 4
A
B
320
296
3
37
3
3
41
6
4
A
1:3
1
46
30
B
1:3
620
Visible Surface
Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa missään muodossa eikä mihinkään tarkoitukseen, ilman kirjallista lupaa omistajalta.
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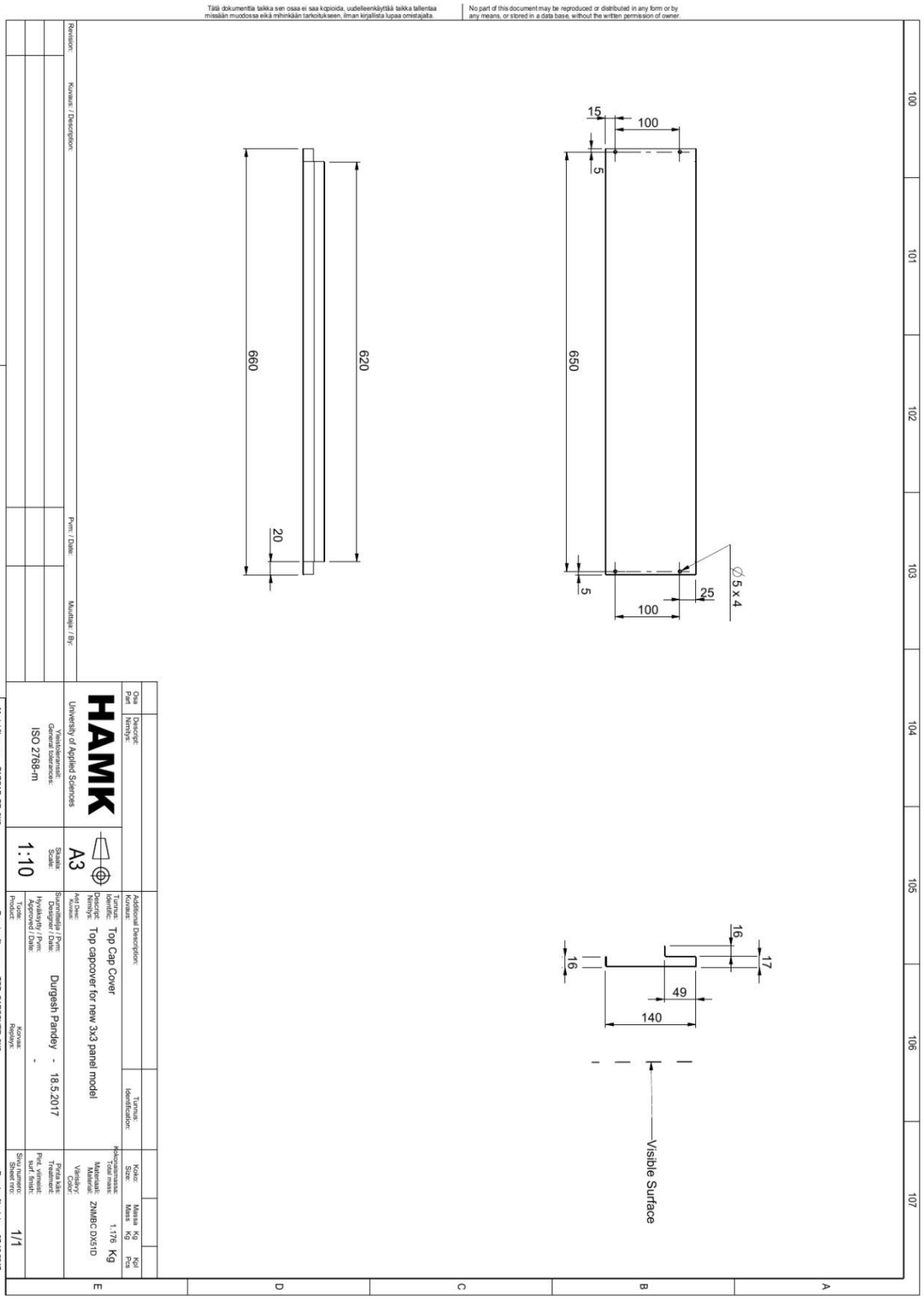
Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
HAMK
University of Applied Sciences
Yleistoleranssit: General tolerances: ISO 2768-m
Mittakaava: Scale: 1:5
Koko: Size: A3
Osa Part
Description: Nimitys:
Additional Description: Kuvaus:
Tunnus: Identific: Three Hole Piece
Description: Nimitys: Three holed piece for new 3x3 panel model
Art.Desc: Kuvaus:
Suunnittelija / Pvm: Designer / Date: Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm: Approved / Date: -
Tuote: Product:
Korvaa: Replaces:
Tunnus: Identification:
Kokonaismassa: Total mass: 1.674 Kg
Materiaali: Material: ZNMBCC DX51D
Väri/pinty: Color:
Pinta käs: Treatment:
Pinn. laatu: Surf. finish:
Sivu numero: Sheet no: 1/1
Kpl/ Pcs
Massa/ Kg Mass
Model filename: THREE_HOLE_PIECE_3X3
Drawing filename: THREE_HOLE_PIECE_3X3_DRW
Drawing file date: 12.09.2017
100
101
102
103
104
105
106
107
E
D
C
B
A


Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa missään muodossa eikä mihinkään tarkoituksiin, ilman kirjallista lupaa omistajalta.
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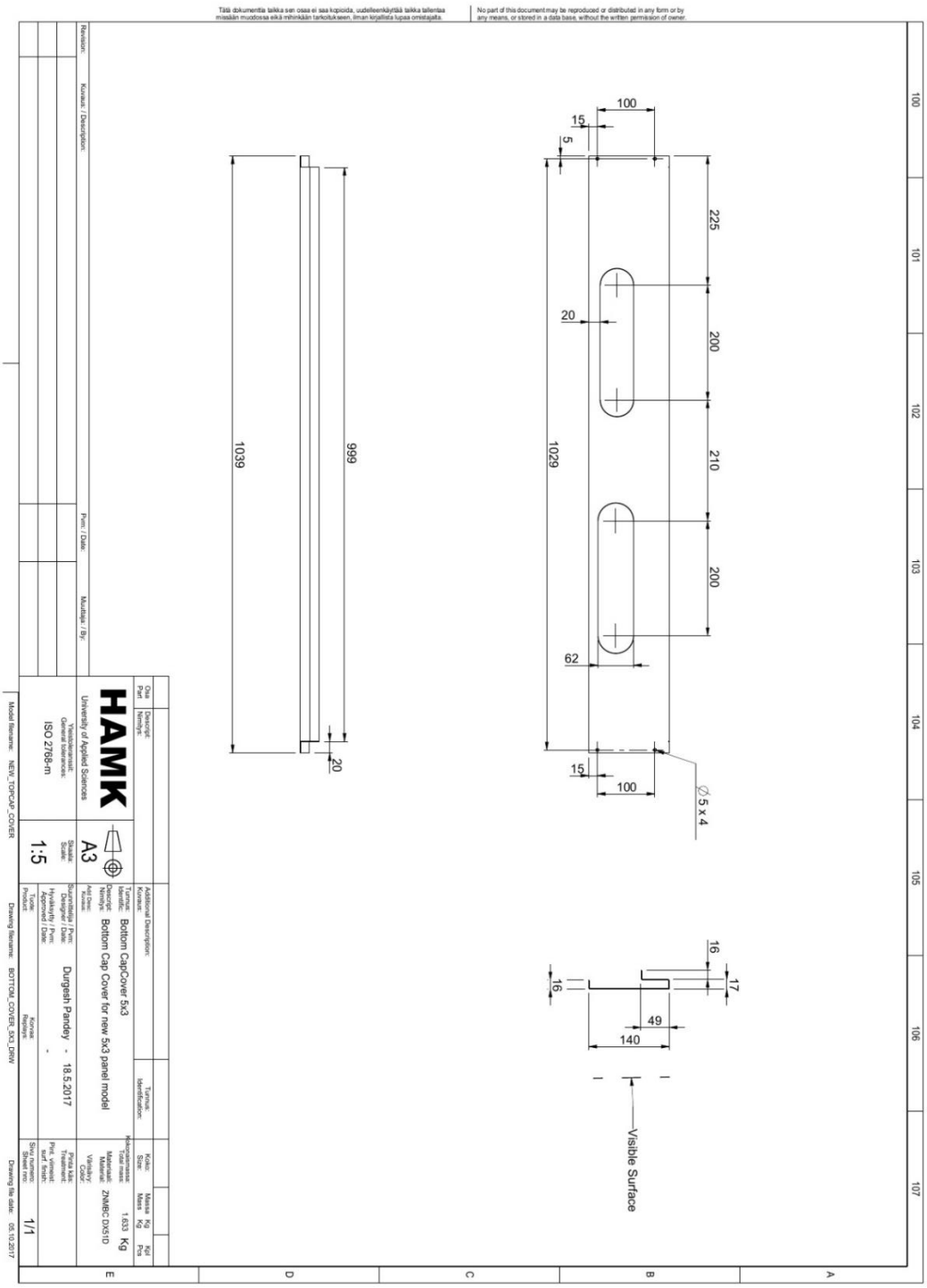
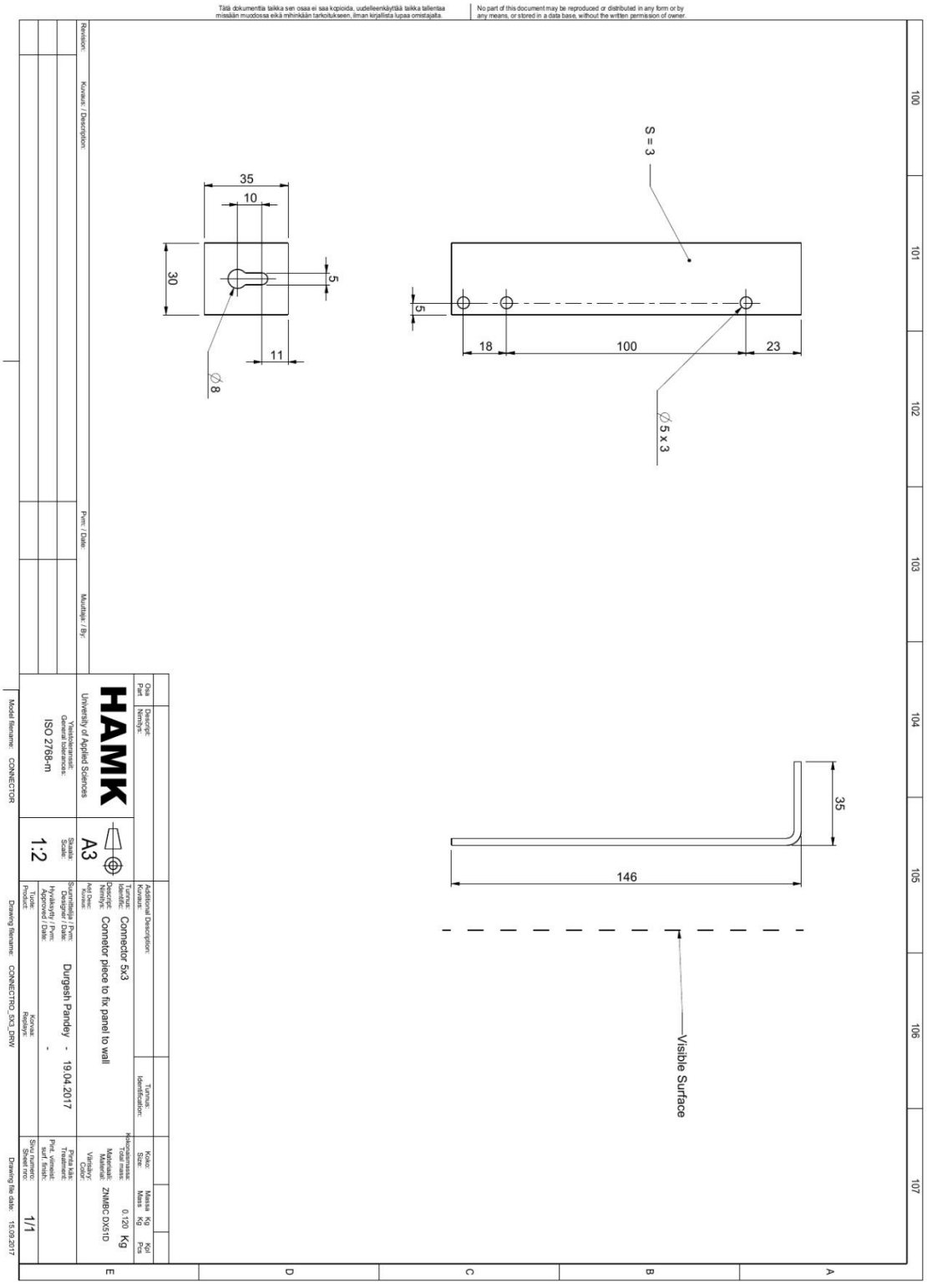
Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
15
100
5
650
5
100
25
∅5 x 4
660
620
20
16
17
16
49
140
Visible Surface
HAMK
University of Applied Sciences
Yleistoleranssit: General tolerances: ISO 2768-m
Osa Part
Description: Nimitys:
Additional Description: Kuvaus:
Tunnus: Identifik:
Top Cap Cover
Nimitys: Identific:
Top capcover for new 3x3 panel model
Mitkä: Dwg no:
Kpl Pcs
Kokoonpanomassa: Total mass:
1.176 Kg
Materiaali: Material:
ZNMBCDX51D
Väri/pinty: Color:
Pinta käs: Treatment:
Pinn. karkeus: Surf. finish:
Sivu numero: Sheet nro:
1/1
Mittakaava: Scale:
1:10
A3
Suunnittelija / Pvm: Designer / Date:
Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm: Approved / Date:
-
Korvaa: Replaces:
Tuote: Product:
Model filename: TAPCAP_BP_3X3
Drawing filename: TOP_CAPCOVER_3X3
Drawing file date: 07.10.2017
100
101
102
103
104
105
106
107
A
B
C
D
E

Appendix 4 Technical drawing for new 5x3 panel model

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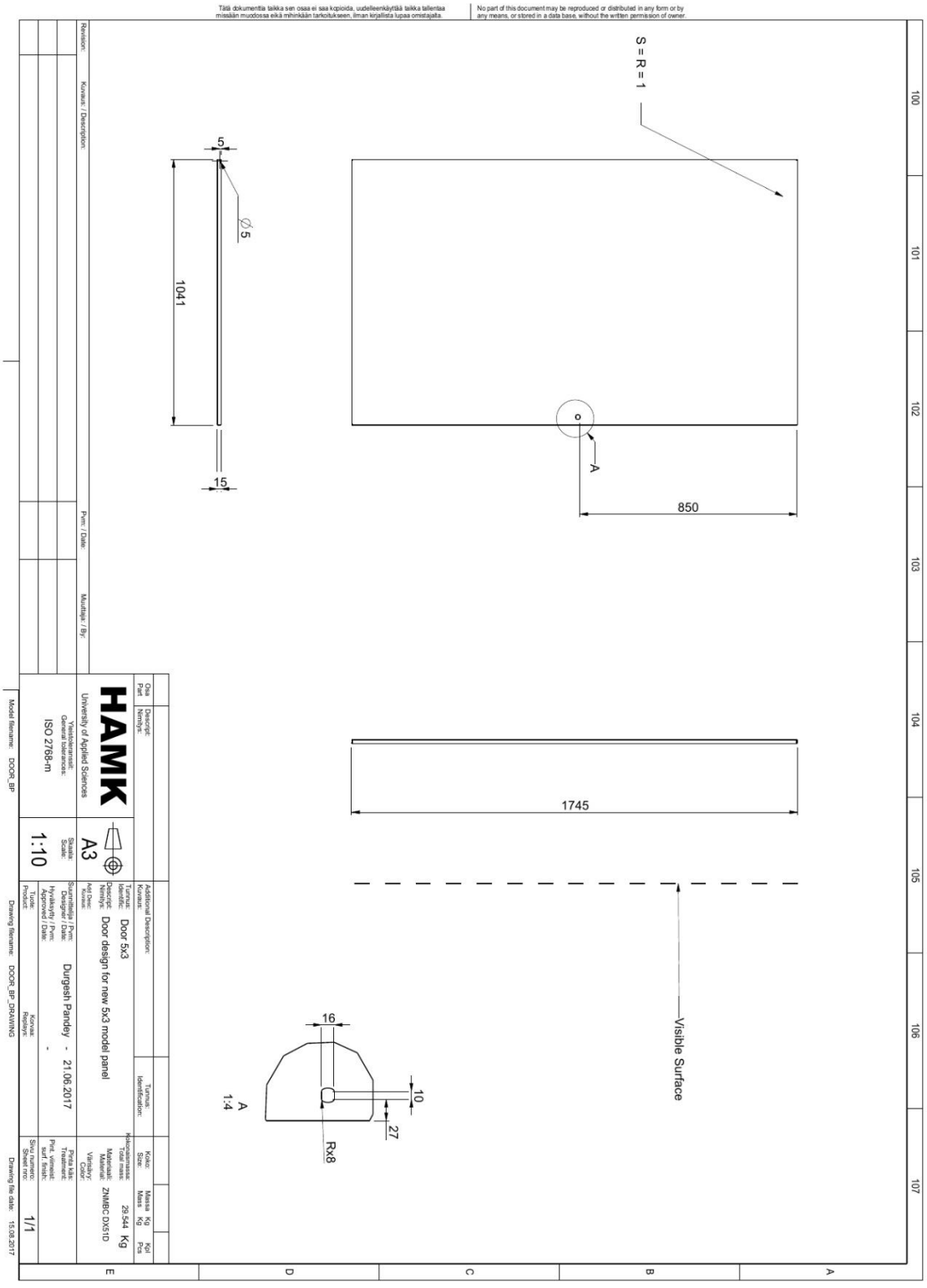
Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
35
10
30
5
11
Ø 8
S = 3
5
18
100
23
Ø 5 x 3
35
146
Visible Surface
Osa Part
Description: Nimitys:
HAMK
University of Applied Sciences
Yleistoleranssit: General tolerances:
ISO 2768-m
Mittakaava: Scale:
A3
1:2
Additional Description: Kuvaus:
Tunnus: Identific:
Connector 5x3
Nimitys: Description:
Connetor piece to fix panel to wall
Tunnus: Identification:
Kpl Pcs
Kokoonpanomassa: Total mass:
0.120 Kg
Materiaali: Material:
ZNMBCDX51D
Väri/pinty: Color:
Piirtäjä / Pvm: Designer / Date:
Durgesh Pandey - 19.04.2017
Hyväksyjä / Pvm: Approved / Date:
-
Pinta käs: Treatment:
Pinn. viimeist.: Surf. finish:
Koko: Size:
Massa Kg Mass Kg
Korvaa: Replaces:
Tuote: Product:
Sivu numero: Sheet no:
1/1
Model filename: CONNECTOR
Drawing filename: CONNECTRO_5X3_DRW
Drawing file date: 15.09.2017
100
101
102
103
104
105
106
107
A
B
C
D
E


Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa
missään muodossa eikä mihinkään tarkoitukseen, ilman kirjallista lupaa omistajalta.
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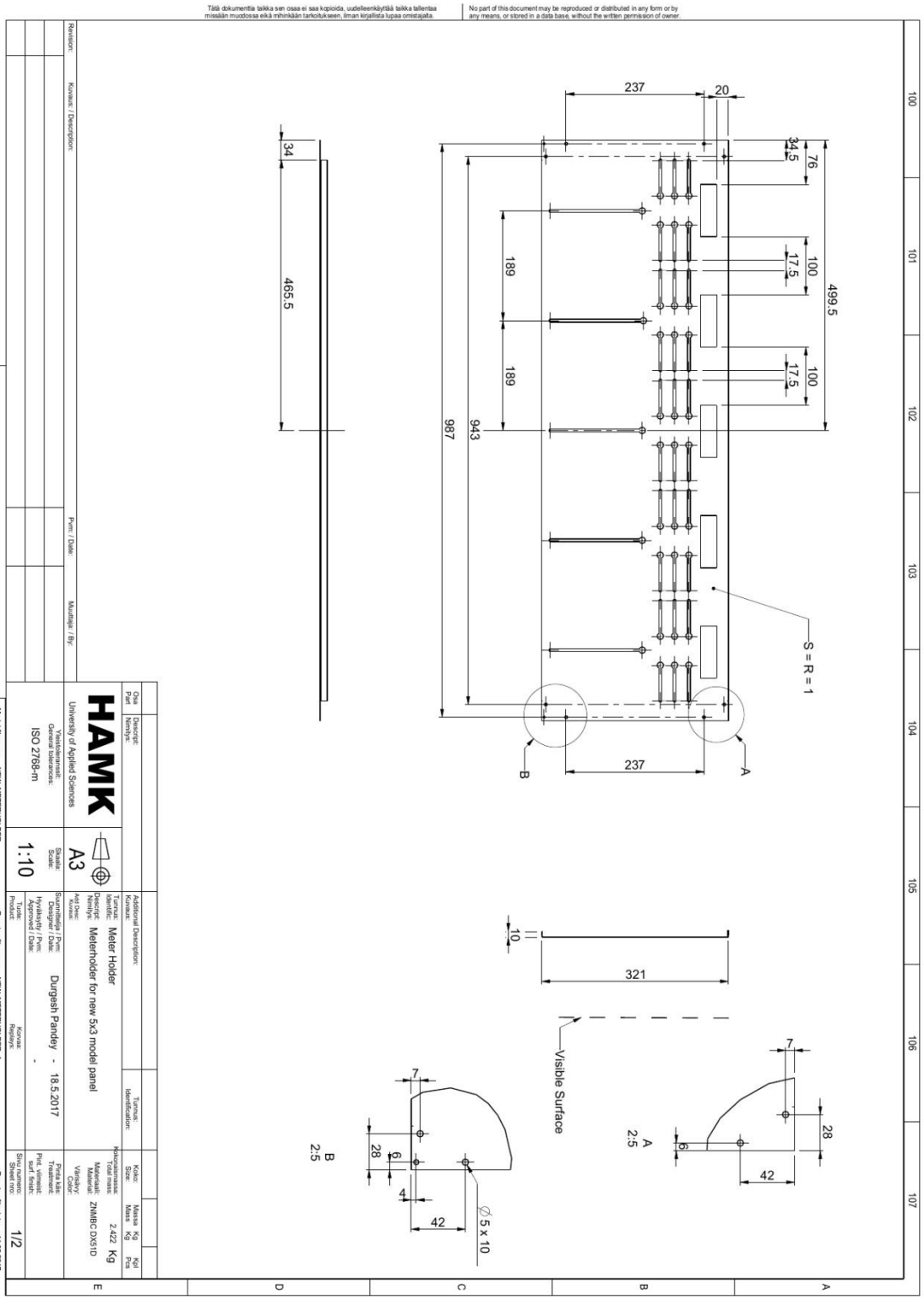
any means, or stored in a data base, without the written permission of owner.
S = R = 1
5
Ø5
1041
15
A
850
1745
Visible Surface
16
10
27
Rx8
A
1:4
HAMK
University of Applied Sciences
Door 5x3
Door design for new 5x3 model panel
Durgesh Pandey - 21.06.2017
ISO 2768-m
A3
1:10
ZNMBC DX51D
29.544 Kg
1/1
DOOR_BP
DOOR_BP_DRAWING
15.08.2017


Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa
missään muodossa eikä mihinkään tarkoitukseen, ilman kirjallista lupaa omistajalta.
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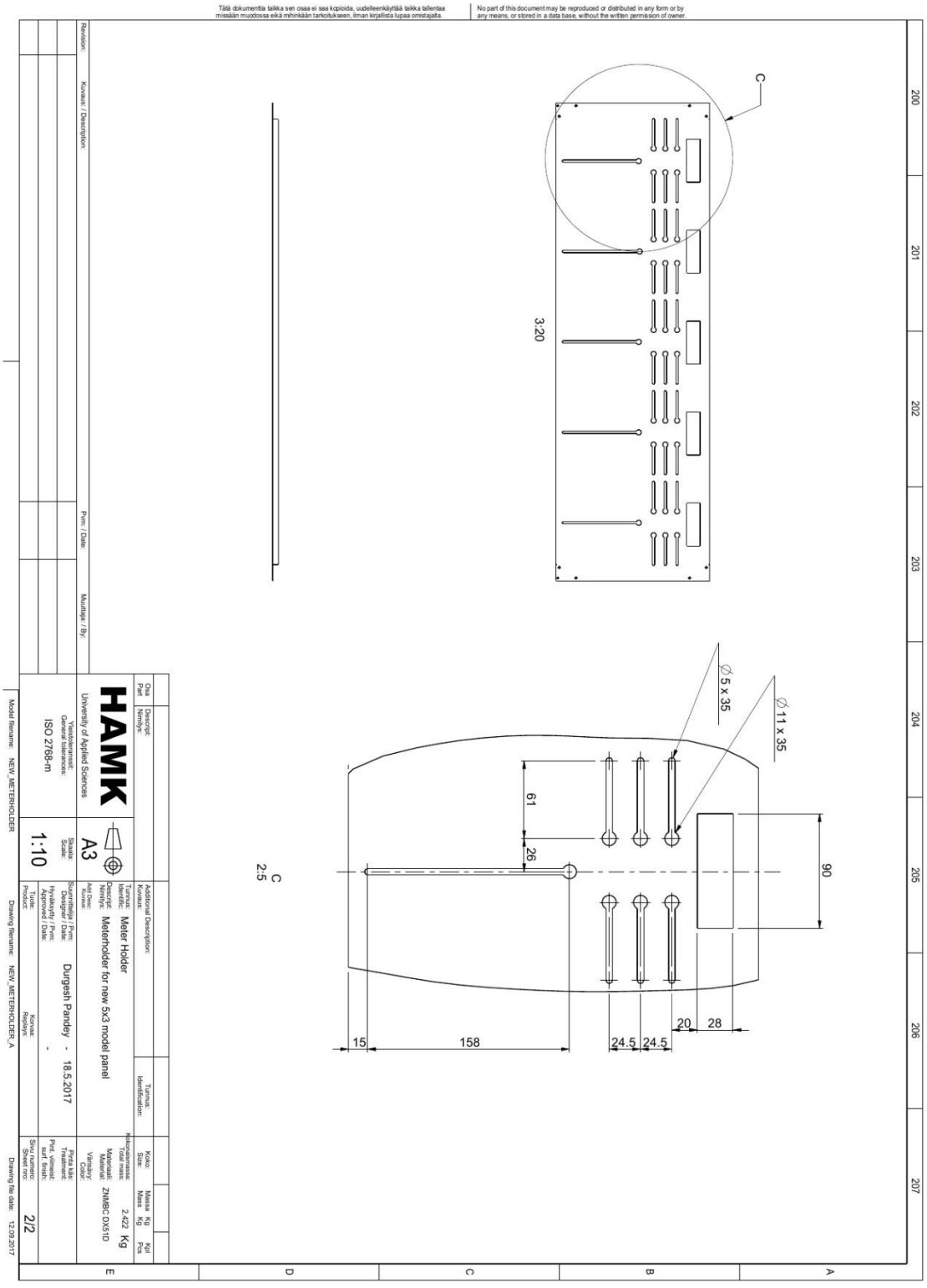
237
20
34.5
76
100
17.5
499.5
189
189
100
17.5
987
943
34
465.5
S = R = 1
237
B
A
10
321
Visible Surface
7
28
6
42
A
2:5
7
28
6
42
4
Ø 5 x 10
B
2:5
HAMK
University of Applied Sciences
A3
1:10
ISO 2768-m
Meterholder for new 5x3 model panel
Meter Holder
Durgesh Pandey - 18.5.2017
2.422 Kg
ZNMBCDX51D
1/2
NEW_METERHOLDER
NEW_METERHOLDER_A
11.09.2017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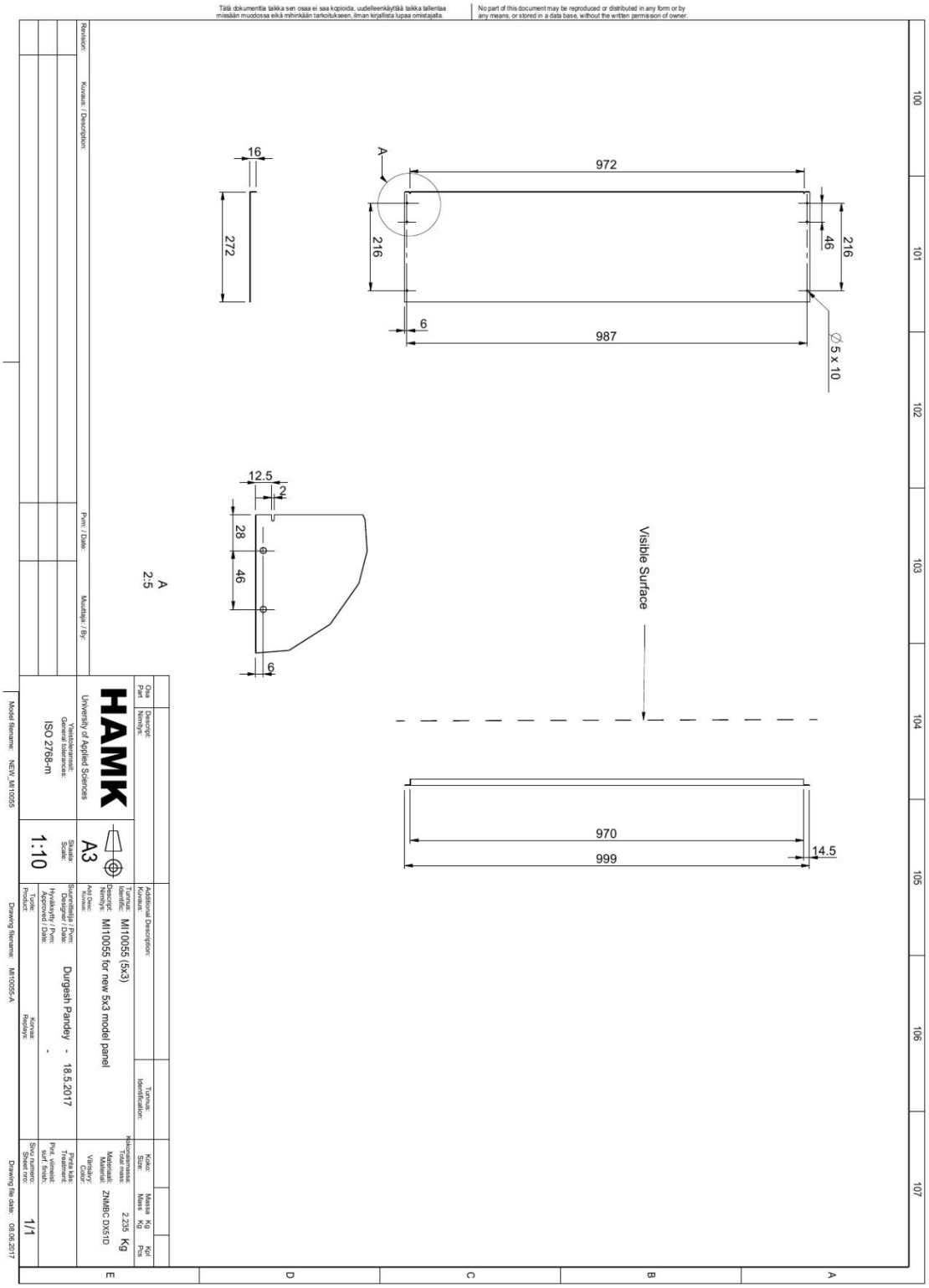
C
3:20
Ø 5 x 35
Ø 11 x 35
61
26
90
15
158
24.5
24.5
20
28
C
2:5
HAMK
University of Applied Sciences
A3
1:10
ISO 2768-m
Meterholder for new 5x3 model panel
Meter Holder
Durgesh Pandey - 18.5.2017
ZNMBC DX51D
2,422 Kg
2/2
NEW_METERHOLDER
NEW_METERHOLDER_A
12.09.2017


Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa missään muodossa eikä mihinkään tarkoitukseen, ilman kirjallista lupaa omistajalta.
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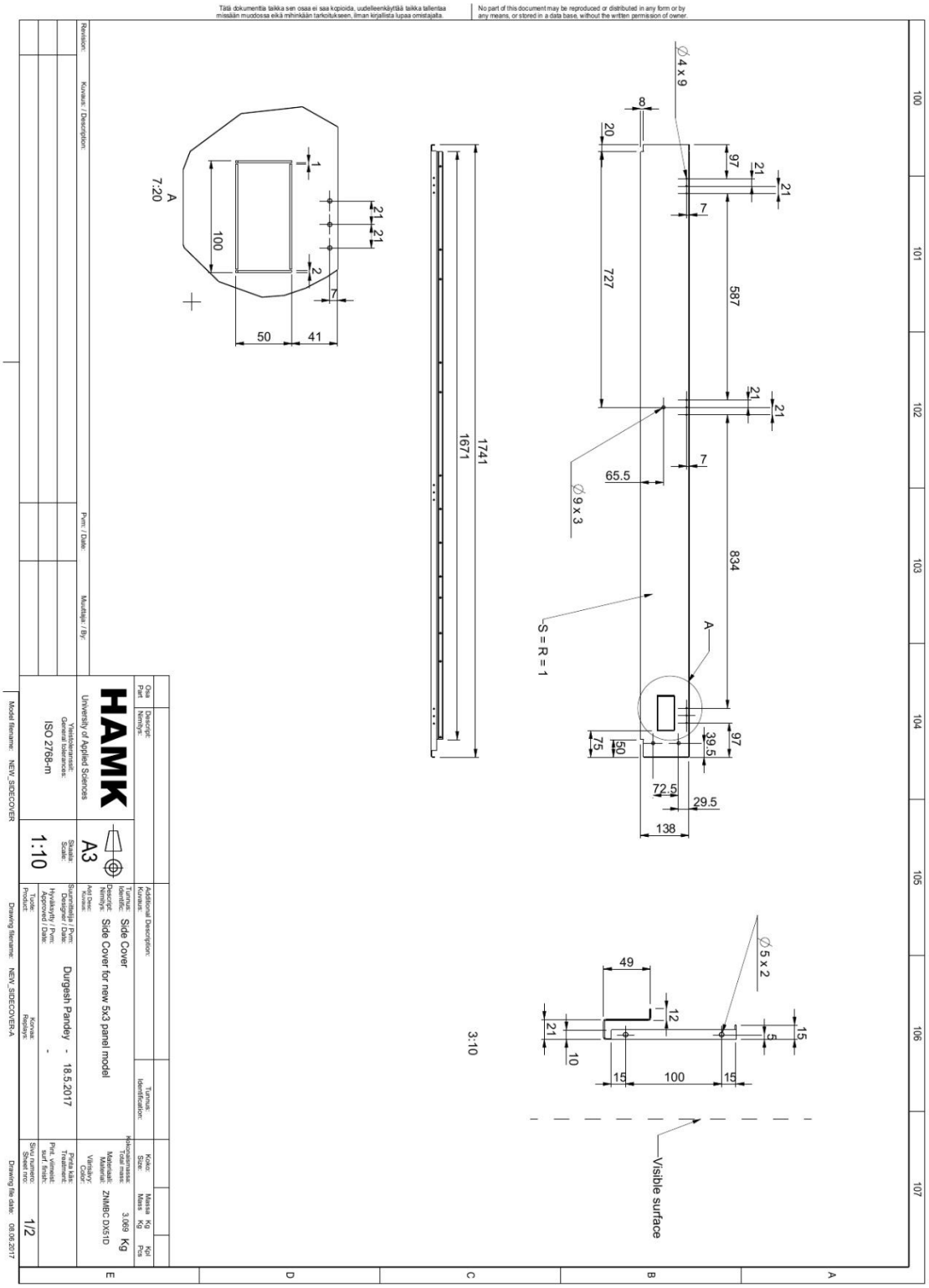
Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
16
272
A
972
216
46
216
6
987
∅ 5 x 10
12.5
2
28
46
6
A
2:5
Visible Surface
970
999
14.5
HAMK
University of Applied Sciences
Yleistoleranssit:
General tolerances:
ISO 2768-m
Skaala:
Scale:
1:10
A3
Osa
Part
Description:
Nimitys:
Additional Description:
Kuvaus:
Tunnus:
Identific:
MI10055 (5x3)
Description:
Nimitys:
MI10055 for new 5x3 model panel
Add Desc:
Kuvaus:
Suunnittelija / Pvm:
Designer / Date:
Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm:
Approved / Date:
-
Tuote:
Product:
Korvaa:
Replaces:
Tunnus:
Identification:
Koko:
Size:
Kokonaismassa:
Total mass:
Massa Kg
Mass Kg
2.235
Kg
Kpl
Pcs
Materiaali:
Material:
ZNMBC DX51D
Värisävy:
Color:
Pinta käs:
Treatment:
Pinn. käsittely:
Surf. finish:
Sivu numero:
Sheet nro:
1/1
Model filename:
NEW_MI10055
Drawing filename:
MI10055-A
Drawing file date:
08.06.2017
E
D
C
B
A
100
101
102
103
104
105
106
107


Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa missään muodossa eikä mihinkään tarkoituksseen, ilman kirjallista lupaa omistajalta.
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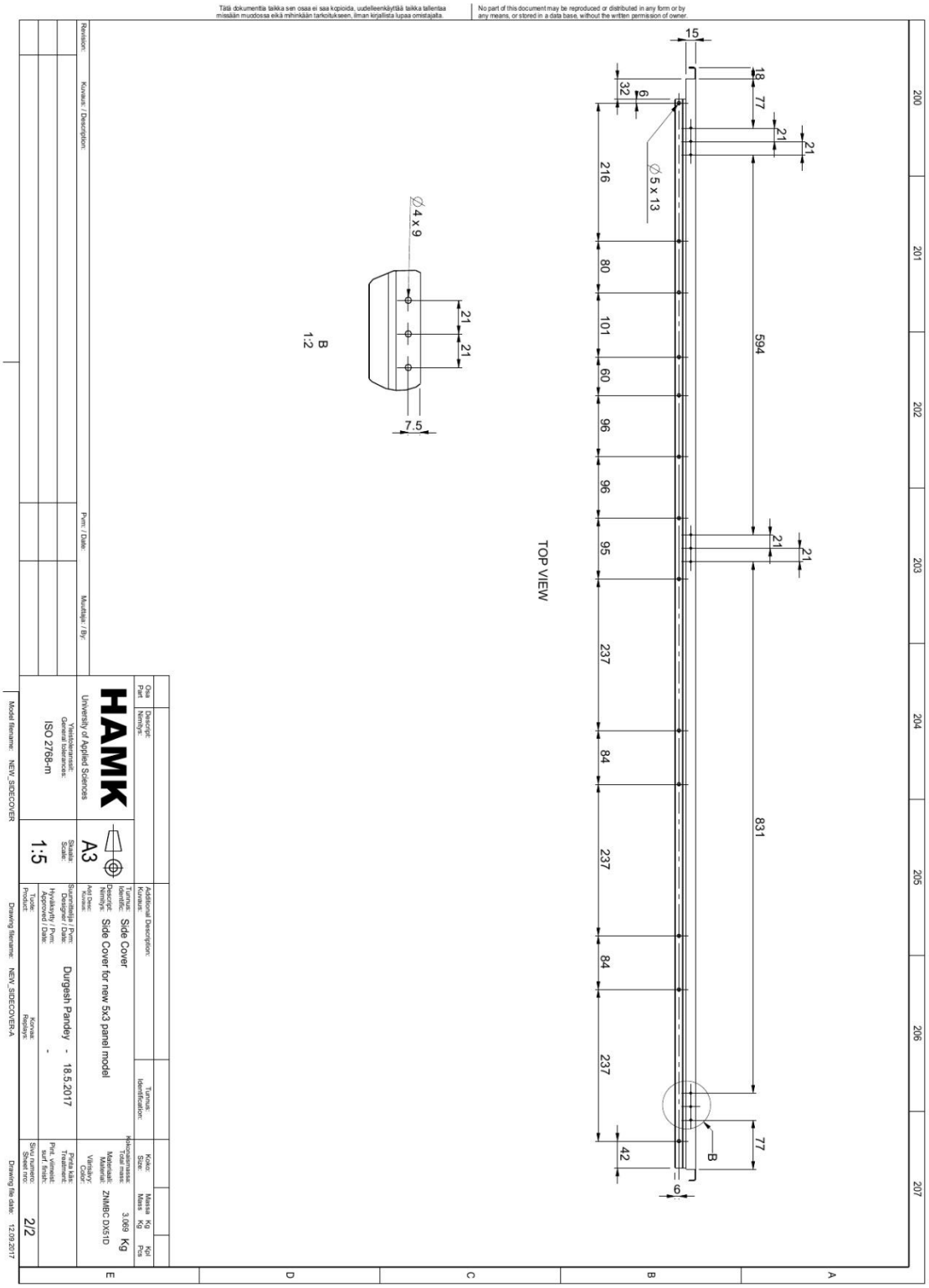
Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
HAMK
University of Applied Sciences
Yleistoleranssit: General tolerances: ISO 2768-m
Skaala: Scale: 1:10
A3
Side Cover
Side Cover for new 5x3 panel model
Durgesh Pandey - 18.5.2017
Model filename: NEW_SIDECOVER
Drawing filename: NEW_SIDECOVER-A
Drawing file date: 08.06.2017
Kokonaismassa: Total mass: 3,069 Kg
Materiaali: Material: ZNMBC DX51D
1/2
Ø 4 x 9
Ø 9 x 3
Ø 5 x 2
S = R = 1
A
A 7:20
3:10
Visible surface
1741
1671
727
587
834
65.5
138
100
50
41
49
72.5
29.5
39.5
97
75
20
8
21
7
2
1
12
5
15
10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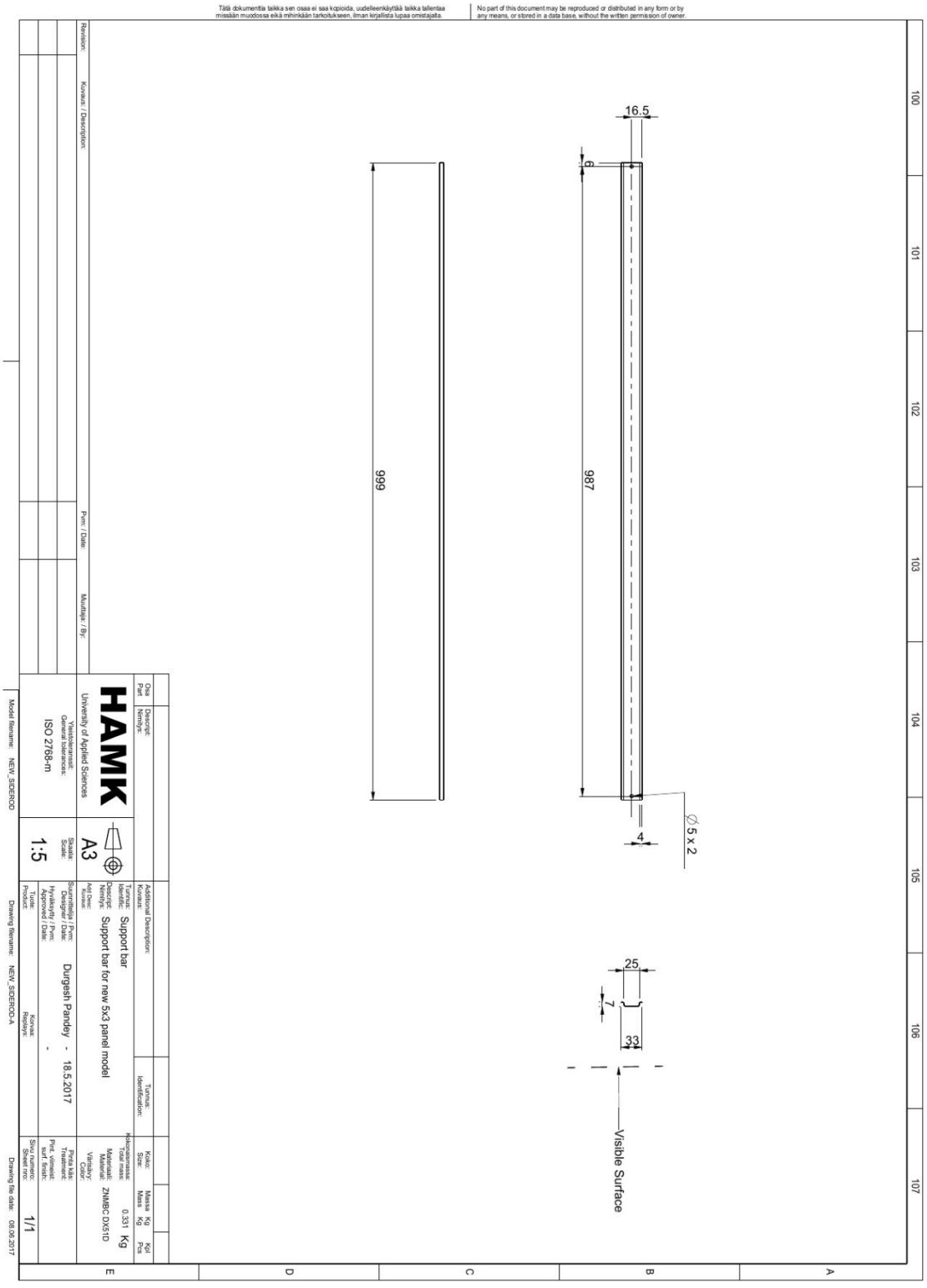
TOP VIEW
B
1:2
HAMK
University of Applied Sciences
Side Cover
Side Cover for new 5x3 panel model
Durgesh Pandey - 18.5.2017
ISO 2768-m
A3
1:5
ZNMBC DX51D
3,069 Kg
2/2
Model filename: NEW_SIDECOVER
Drawing filename: NEW_SIDECOVER-A
Drawing file date: 12.09.2017


Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa
missään muodossa eikä mihinkään tarkoitukseen, ilman kirjallista lupaa omistajalta.
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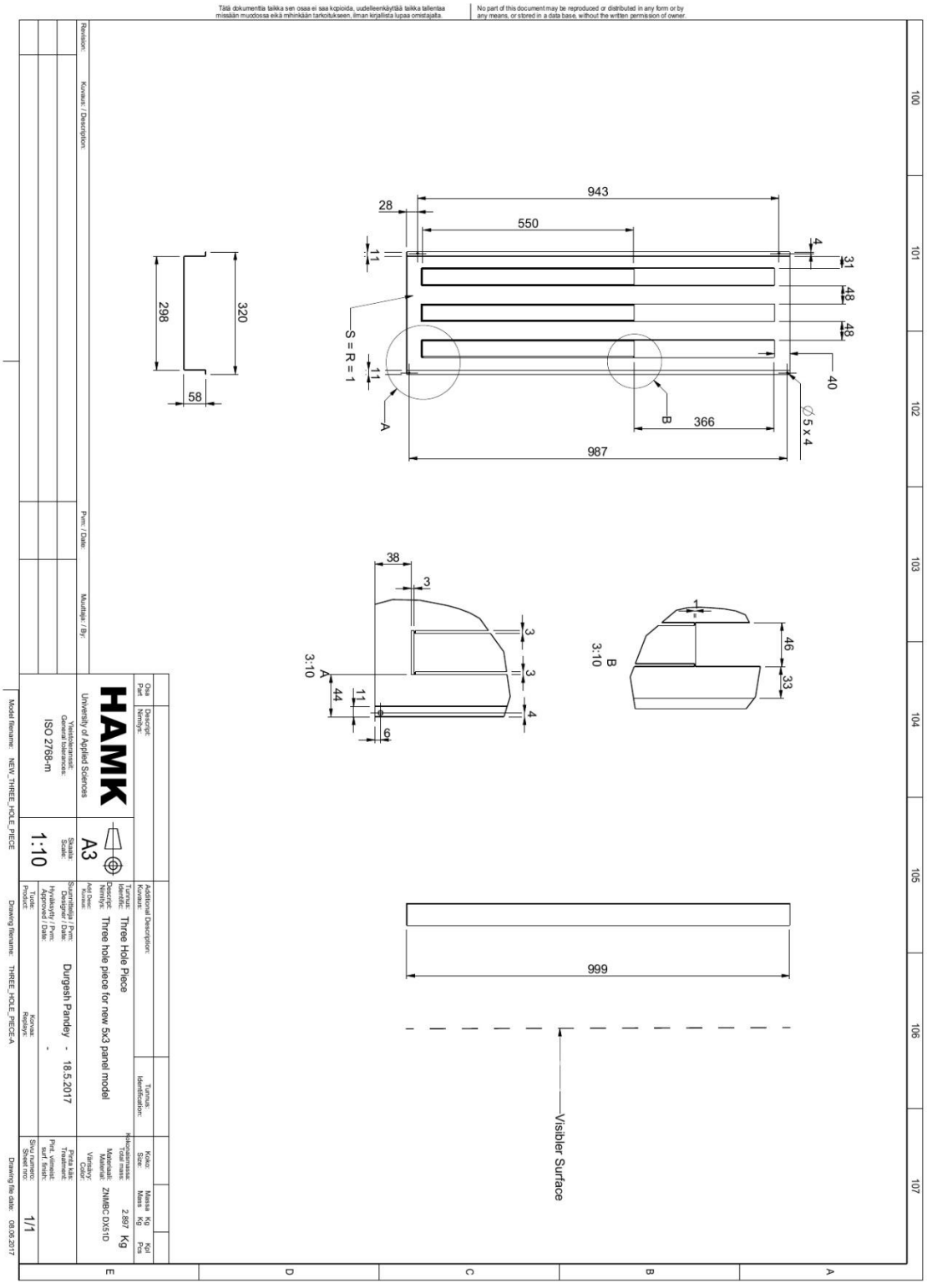
16.5
6
987
999
4
∅ 5 x 2
25
7
33
Visible Surface
Revision:
Kuvaus / Description:
Pvm. / Date:
Muuttaja / By:
HAMK
University of Applied Sciences
Yleistoleranssit:
General tolerances:
ISO 2768-m
Osa
Part
Description:
Nimitys:
Additional Description:
Kuvaus:
Tunnus:
Identific:
Support bar
Support bar for new 5x3 panel model
Tunnus:
Identification:
Mittakaava:
Scale:
1:5
A3
Suunnittelija / Pvm:
Designer / Date:
Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm:
Approved / Date:
-
Tuote:
Product:
Korvaa:
Replaces:
Kpl
Pcs
Kokonaismassa:
Total mass:
0.331 Kg
Materiaali:
Material:
ZNMBC DX51D
Väri/pinty:
Color:
Pinta käs:
Treatment:
Pinn.viimeist.:
Surf. finish:
Sivu numero:
Sheet no:
1/1
Model filename: NEW_SIDEROD
Drawing filename: NEW_SIDEROD-A
Drawing file date: 08.06.2017
A
B
C
D
E
100
101
102
103
104
105
106
107


Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa
missään muodossa eikä mihinkään tarkoitukseen, ilman kirjallista lupaa omistajalta.
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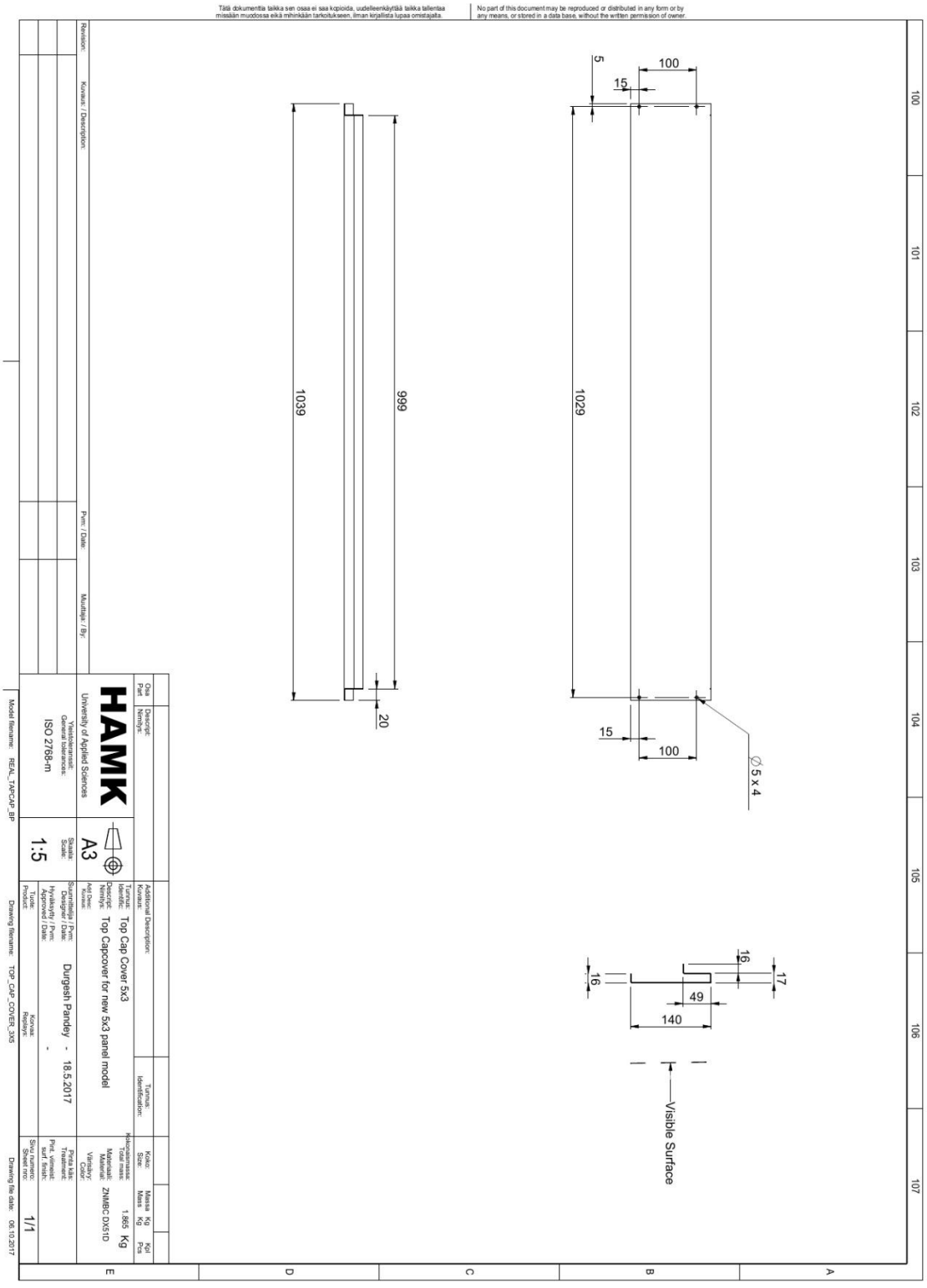
Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
HAMK
University of Applied Sciences
Yleistoleranssit:
General tolerances:
ISO 2768-m
Skaala:
Scale:
1:10
A3
Osa
Part
Description:
Nimitys:
Additional Description:
Kuvaus:
Tunnus:
Identific:
Three Hole Piece
Description:
Nimitys:
Three hole piece for new 5x3 panel model
Art.Desc:
Kuvaus:
Suunnittelija / Pvm:
Designer / Date:
Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm:
Approved / Date:
-
Tuote:
Product
Korvaa:
Replaces
Tunnus:
Identification:
Koko:
Size:
Kokonaismassa:
Total mass:
Massa Kg
Mass Kg
2.897 Kg
Materiaali:
Material:
ZNMBC DX51D
Värisävy:
Color:
Pinta käs:
Treatment:
Pinn. laatu:
Surf. finish:
Sivu numero:
Sheet no:
1/1
Kpl
Pcs
Model filename: NEW_THREE_HOLE_PIECE
Drawing filename: THREE_HOLE_PIECE-A
Drawing file date: 08.06.2017
943
550
28
11
4
31
48
48
40
S = R = 1
A
B
366
987
∅5 x 4
298
320
58
38
3
3
3
3
4
44
11
6
A
3:10
B
3:10
46
33
999
Visibler Surface
100
101
102
103
104
105
106
107
E
D
C
B
A


Tätä dokumenttia laikka sen osaa ei saa kopioida, uudelleenkäyttää laikka tallentaa missään muodossa eikä mihinkään tarkoitukseen, ilman kirjallista lupaa omistajalta.
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Revision:
Kuvaus: / Description:
Pvm: / Date:
Muuttaja: / By:
Osa Part
Description: Nimitys:
HAMK
University of Applied Sciences
Yleistoleranssit: General tolerances:
ISO 2768-m
Skaala: Scale:
A3
1:5
Additional Description:
Kuvaus:
Tunnus: Identific:
Top Cap Cover 5x3
Description: Nimitys:
Top Capcover for new 5x3 panel model
Tunnus: Identification:
Antt.Desc: Kuvaus:
Suunnittelija / Pvm: Designer / Date:
Durgesh Pandey - 18.5.2017
Hyväksyjä / Pvm: Approved / Date:
-
Tuote: Product:
Korvaa: Replaces:
Kpl Pcs
Massa Kg Mass Kg
Koko: Size:
Kokonaismassa: Total mass:
1.865 Kg
Materiaali: Material:
ZNMBC DX51D
Värisävy: Color:
Pinta käs: Treatment:
Pinta laatu: Surf. finish:
Sivu numero: Sheet no:
1/1
Model filename: REAL_TAPCAP_BP
Drawing filename: TOP_CAP_COVER_3X5
Drawing file date: 06.10.2017
100
101
102
103
104
105
106
107
A
B
C
D
E
5
100
15
1029
1039
999
20
15
100
Ø5 x 4
16
17
16
49
140
Visible Surface